OPERATION & MAINTENANCE MANUAL
ISVE SYSTEMS

AMERICAN CHEMICAL SERVICE NPL SITE
GRIFFITH, INDIANA

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Prepared For:

American Chemical Service NPL Site RD/RA Executive Committee
Griffith, Indiana

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MWH

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ACRONYMS AND COMMON TERMS

ACS	American Chemical Services
AS	air sparge
bgs	below ground surface
BWES	Barrier Wall Extraction System
cfm	cubic feet per minute
COC	Chain-of-Custody for sample transportation and analysis
CPVC	Chlorinated polyvinyl chloride
^oF	degrees Fahrenheit
DPE	Dual-phase extraction
FID	Flame-ionization detector
FRP	fiber-glass reinforced plastic
GLI	Great Lakes Instruments
GWTP	Groundwater treatment plant
HDPE	High density polyethylene
hp	Horse power
HS	Hand switch
IDEM	Indiana Department of Environmental Management
" H_2O	inches of water
ISVE	In-situ soil vapor extraction
K-P Area	Kapica-Pazmey Area (located at the south end of the Off-Site Area)
mA	milliamp (electrical current)
MCC	Motor Control Center
ME	Mechanical equipment designation
MMI	Man-machine interface (the GWTP control computer)
mS/cm	microSiemens per centimeter
MWH	MWH Americas, Inc.
NPL	National Priority List
O&M	Operation & Maintenance
OFCA	Off-Site Containment Area (the area of high contamination in the Off-Site Area)
Off-Site Area	The area within the barrier wall south of the railroad tracks
ONCA	On-Site Containment Area (the area of high contamination in the On-Site Area)
On-Site Area	The area within the barrier wall north of the railroad tracks
P	Pump designation
PID	Photo-ionization detector
PLC	Programmable Logic Controller
PM	Project Manager
PP	Designator for the BWES well pumps
PPE	Personal Protective equipment
psi	pounds per square inch
PSVP	Performance Standard Verification Plan

ACRONYMS AND COMMON TERMS
(Continued)

PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
ROD	Record of Decision
rpm	revolutions per minute
SBPA	Still Bottoms Pond Area (located within the ONCA)
SCFM	Standard cubic feet per minute of air/gas flow
Site	All of the individual ACS areas are collectively referred to as the Site
SSO	Site Safety Officer
SVOC	semi-volatile organic compound
T	Tank designation
U.S. EPA	United States Environmental Protection Agency
VFD	variable frequency drive motor for pumps
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 MANUAL USE AND ORGANIZATION

This document is the Operations and Maintenance (O&M) Manual for the In-Situ Soil Vapor Extraction (ISVE) Systems that were installed as a component of remedial action at the American Chemical Service (ACS) Site in Griffith, Indiana. Two separate ISVE systems were installed and are used to treat separate areas:

- The first system installed serves the Off-Site Containment Area (OFCA) and Kapica-Pazmey Area (K-P Area), and will be referred to as the Off-Site ISVE system; and

- The second system installed serves the Still Bottoms Pond Area (SBPA), located in the On-Site Area, and will be referred to as the SBPA ISVE system.

Construction of the Off-Site ISVE system was completed in 2001 and construction of the SBPA ISVE system was completed in 2003. These ISVE systems were constructed as part of the implementation of the Final Remedial Design Report (Montgomery Watson, August 1999). Both systems consist of ISVE wells, air sparge (AS) points, conveyance piping, and system buildings that house the equipment for each system. In addition, the SBPA ISVE system incorporates dual-phase extraction (DPE) at select ISVE well locations.

This O&M Manual provides information for operation and maintenance of the treatment equipment. The manual describes the overall systems and the processes for control, startup, normal operation, and shutdown of the equipment.

Health and Safety procedures are not addressed in this manual. Information pertaining to health and safety may be found in the Site Health and Safety Plan and associated addenda.

This plan is intended to be used in conjunction with the O&M manuals provided by the manufacturers of the equipment, and as such, it does not focus on routine maintenance and calibration of standard equipment items. Reference to the manufacturers' O&M manuals is made throughout this plan, and it is therefore recommended that the system operator become familiar with those documents as well. These manuals are located in the office at the Groundwater Treatment Plant (GWTP) at the ACS Site.

This O&M Manual is designed to provide the plant operator with sufficient background and appropriate procedures for day-to-day operation and maintenance of the ISVE systems and associated vapor treatment units. The manual includes:

- An overall description of the two ISVE systems and associated vapor treatment equipment (thermal oxidizers);

- A detailed description of the vapor extraction and treatment components;

- Individual equipment descriptions, identifying major components, procedures, and process control provisions (where applicable); and

- A sampling and analytical program and a method of record keeping and reporting.

It should be emphasized that specific maintenance information on each piece of equipment is provided in the equipment manufacturers' O&M manuals located in the GWTP office.

1.2 SITE BACKGROUND

The ACS chemical manufacturing facility is still actively operating within the ACS National Priority List (NPL) Site. Past operations by ACS Inc. have impacted five land disposal areas: the On-Site Containment Areas (ONCA), the SBPA, the Treatment Lagoon, the OFCA, and the K-P Area. The OFCA and K-P Area are located in the part of the site referred to as the Off-Site Area. The ONCA, SBPA, and the Former Treatment Lagoon are located in the part of the site referred to as the On-Site Area. A site map is shown on Figure 1.

In 1997, MWH Americas, Inc. (MWH) installed a 4,400-foot long continuous perimeter barrier wall around the On-Site and Off-Site Areas that encloses the Site. MWH installed a Separation Barrier Wall within the perimeter barrier wall from January to February 2001. The Separation Barrier Wall provides vertical, hydraulic separation of groundwater inside the larger barrier wall to minimize migration of groundwater between the On-Site Area and the Off-Site Area. The barrier walls are keyed into a clay layer approximately 20 to 30 feet below ground surface (bgs). Figure 1 shows the locations of the Separation Barrier Wall and the original Barrier Wall installed along the perimeter of the Site.

A groundwater extraction system was installed to maintain hydraulic capture inside the barrier wall. This system, referred to as the Barrier Wall Extraction System (BWES), includes ten extraction trenches. Extraction wells were installed at the end of each trench to collect the groundwater. One of the main objectives of the BWES is to dewater the On-Site and Off-Site Areas to allow for effective operation of the ISVE systems. Water collected by the BWES is treated at the GWTP located west of the On-Site Area.

Further information regarding the history of the ACS NPL Site is available in the *Final Remedial Design Report* (Montgomery Watson, August 1999) and the multiple construction completion reports developed for each of the Final Remedy activities.

Construction on the Off-Site Area ISVE system began in August 2001. The 42 ISVE wells and three AS points were installed in August and September of 2001. The system building was also constructed during this time. The thermal oxidizer and scrubber unit were installed in February 2002.

Construction of the SBPA ISVE system began in 2002 and the 25 ISVE wells, 21 DPE wells, and six AS points were installed between October and November of 2002. Two system buildings were completed and installed in May 2003; one building houses the ISVE system blower and the ISVE piping, the other building houses the electrical and control components, as well as equipment associated with the AS and DPE air supply systems. The thermal oxidizer and scrubber unit were installed at the GWTP in May 2003.

1.3 ISVE SYSTEM REMEDIAL OBJECTIVES

Since the barrier wall already contains the source areas at the Site, the primary objective of ISVE at the ACS Site is reduction of mobile contaminants in the source areas by extracting volatile organic compounds (VOCs) and, to some extent, semivolatile organic compounds (SVOCs). Implementation of ISVE technology is consistent with the objectives of the Final Remedy for the ACS Site, as defined in the Record of Decision (ROD), to address the principle threat by reducing the risk of exposure to contaminated vapors and reducing the potential migration of mobile contaminants to the groundwater.

Applying ISVE to the source areas will decrease the mass of the mobile contaminants within the barrier wall. This reduction, in conjunction with the barrier wall, cover systems, and groundwater pump and treat system, will further reduce the potential for off-site contaminant migration.

In addition, ISVE will reduce the potential for contact with the contaminants through the ground surface by reducing the subsurface contamination and it will minimize the VOC loading in the GWTP by removing VOCs before they dissolve into the groundwater.

The objective of the AS systems in the SBPA and Off-Site Area is to treat areas of VOC contamination that are below the target groundwater elevations. Air injected by the AS system induces volatilization and introduces oxygen into the groundwater to promote biodegradation. When used in conjunction with ISVE, the volatiles stripped from the soil matrix by sparging will be collected by the ISVE system.

Further discussion regarding the design of the ISVE system is available in the *Final Remedial Design Report* (Montgomery Watson, August 1999).

1.4 ASSOCIATED DOCUMENTS

Additional information regarding the ISVE systems can be found in the *Off-Site Containment Area and Kapica-Pazmey Area In-Situ Soil Vapor Extraction Systems Construction Completion Report* (MWH, April 2003) and the *Still Bottoms Pond Area In-Situ Soil Vapor Extraction System Construction Completion Report* (MWH, January 2004).

Information regarding monitoring requirements may be found in the *Performance Standard Verification Plan* (MWH, June 1999). Health and safety procedures may be found in the *Health and Safety Plan* (MWH, 1999) and its associated addenda.

2.0 SYSTEM DESCRIPTION

The two separate ISVE systems were installed to address areas of the site containing the most elevated subsurface VOC concentrations. The Off-Site ISVE Area system was constructed to treat the OFCA and the K-P Area, and the SBPA ISVE System was constructed to treat the SBPA. The Off-Site Area System was constructed to treat source zones in the Off-Site Containment Area and the K-P Area. Process flow diagrams, details, plans and layouts of each ISVE system are depicted in Figures 1 through 12. This section provides a description of both systems.

The Off-Site Area system, consisting of two main blowers, has a nominal capacity of 2,000 cubic feet per minute (cfm). The SBPA system consists of one blower that has a nominal capacity of 1,000 cfm. Two vapor treatment systems (thermal oxidizers with associated scrubbers) were installed at the GWTP. The vapors extracted from the ISVE systems can be sent to either of the vapor treatment systems.

2.1 OFF-SITE AREA SYSTEM

The Off-Site Area ISVE system consists of the following major components:

- Forty-two ISVE wells (12 located in the K-P Area and 30 in the OFCA)
- Conveyance piping
- Vacuum blower systems (two blowers total)
- Condensate removal systems
- Extracted vapor treatment system
- Controls and instrumentation
- Three AS points

A process flow diagram is included as Figure 5. An equipment index for the Off-Site Area ISVE system is included as Table 1. The ISVE blowers provide a vacuum at the ISVE wells and pulls the extracted vapors to the system building via the conveyance piping. In the system buildings, the individual conveyance pipes merge into a header system and the collected vapors are directed through the condensate removal system (knockout tank).

Two knockout tanks (one for each ISVE blower) with a demister removes entrained water collected with the extracted vapors. The collected water (condensate) is pumped to the GWTP for treatment.

The extracted vapors are then treated by one of the two thermal oxidizer/scrubber systems located at the GWTP to remove the contaminants from the vapor stream prior to discharge to the atmosphere. The thermal oxidizer heats the air stream to a temperature of approximately 1,500 degrees Fahrenheit (°F) to combust the volatile contaminants of the vapor stream.

The scrubber removes the byproduct of the combustion process, hydrochloric acid gas, before the treated air is discharged to the atmosphere.

2.1.1 Wellfield

Figure 2 depicts the layout of the ISVE wells and AS points in the Off-Site Area. Construction details for each of the drilled points are included in Figure 2. Detailed drawings of typical ISVE and AS points are included on Figure 4. The following subsections provide a description of each type of installed well.

2.1.1.1 ISVE Wells

Ten-inch diameter boreholes were drilled to the specified depth using 6¼-inch inside diameter hollow-stem augers for each ISVE well location. The ISVE wells were installed with total depths ranging from 15 to 25 feet bgs. Installation depths for each well are included in Figure 2. The ISVE wells are constructed of four-inch diameter, 304 stainless steel riser pipes with a screen length of either 10 or 15 feet. The screens have a slot size of 0.020 inches. The riser pipe at each well extends between three and five feet above the ground surface.

In each well, a sand filter pack was installed from the bottom of the boring to six inches above the top of the screen. One foot of bentonite chips was placed above the filter pack and then hydrated. The chips were allowed to hydrate for approximately ten minutes to ensure the formation of a bentonite seal immediately above the filter pack. The remainder of the annular space was filled with bentonite grout.

2.1.1.2 Air Sparge Points

The AS points were driven to the target depth utilizing a disposable drive point attached to the casing. The AS points were installed to approximately 29 feet bgs to coincide with the bottom of the upper aquifer. The points were constructed of two-inch diameter, 304 stainless steel well riser pipes with a screen length of two feet and a slot size of 0.020 inches. A sand filter pack was installed to six inches above the top of the screen. The annular space was then filled with bentonite grout to the bottom of the compacted clay cover. Construction details, including installation depths of the AS points are included in Figure 2 (Off-Site Area).

2.1.2 System Buildings

The system buildings house the mechanical equipment for the ISVE system, including the vacuum blowers, knockout tanks and pump, AS system, the ISVE piping manifold, and ISVE control room. The main system building is a 32-foot long, 10-foot wide, 8½-foot high steel tube frame on a base frame made from 10-inch steel C-channels. The building has a ½-inch plywood exterior, R13 insulation on the walls and ceiling, and exterior vinyl siding. It is divided into an equipment room that is rated for potentially hazardous environments and a non-rated control room. The second system building is a 10-foot long, 8-foot wide steel storage container that has been modified to accommodate the second ISVE blower. Figure 6 depicts the layout of the Off-Site Area system buildings.

2.1.3 System Equipment

2.1.3.1 ISVE Blower

The primary ISVE blower is a 30-horsepower, positive displacement blower (Hibon Model No. H/V 815) rated for 1,000 standard cubic feet per minute (scfm) at a vacuum of 95 inches of water (" H_2O) and a discharge pressure of 23" H_2O. Prior to startup, critical blower components were coated with an acrylic urethane coating to provide chemical and abrasion resistance. The lead time for delivery of this blower with the specified coating has typically been approximately six months.

An evaluation of initial system operation was performed from November 2002 through May 2003. Based on the results of the evaluation, a second blower system was added to the Off-Site Area ISVE system. The second blower is a Gardner-Denver Model 6L rated for 1,000 scfm at a vacuum of 95" H_2O and a discharge pressure of 23" H_2O. It has a dedicated knockout tank and is housed in a separate building. This building is located to the west of the original system building. Piping between the two buildings connects the second blower to the extraction piping manifold and the knockout tank to the condensate pump. Startup of the second blower was performed in November 2004.

2.1.3.2 Air Sparge Blower

The AS blower is a 7.5-horse power (hp), rotary vane pump (Becker Model No. KDT 3.80) rated for 30 cfm at a discharge pressure of 17.8 pounds per square inch (psi).

2.1.3.3 Knockout Tank/Pump

A 500-gallon (250-gallon fluid capacity) stainless steel knockout tank is located in each of the OFCA system buildings. Both tanks have a removable top cover and an internal demister pad. A level sensor has been installed in the tanks. A sight glass allows visual observation of water levels in the tanks. A drain port with a manual ball valve is located near the base of the tanks.

A Moyno-brand progressive cavity, explosion proof pump with a one-horsepower motor is mounted next to the knockout tank in the main system building and is used to transfer water from both knockout tanks to tank T-102 located in the GWTP.

2.1.3.4 Conveyance Piping/Manifold

Conveyance piping was installed to connect the ISVE wells and AS points to the pipe manifold installed in the system building. The conveyance piping and pipe fittings installed below the ground surface include three-inch diameter (ISVE) and two-inch diameter (AS and water) SDR 11 Plexco Perfomance Pipe 1000 Series high density polyethylene (HDPE) pipe. A dedicated conveyance pipe was installed from the system building to each of the ISVE wells and AS points. Figure 3 depicts the approximate locations of the conveyance piping trenches.

The system piping manifold, located in the System Building, is constructed of six-inch diameter Schedule 80 polyvinyl chloride (PVC) pipes. The manifold is comprised of five header branches. Each of the riser pipes installed in the foundation slab is connected to one of these five branches. Two of these headers (KP-1 and KP-2) are connected to the riser pipes corresponding to the K-P Area wells (SVE-1 through SVE-12). The other three headers (OFCA-1, OFCA-2, and OFCA-3) are connected to the riser pipes corresponding to the OFCA wells (SVE-13 through SVE-42). Another six-inch diameter pipe branch was installed to allow a source of ambient air into the vacuum system.

2.1.3.5 System Control Equipment

The Off-Site ISVE System has a dedicated motor control center (MCC) and programmable logic control (PLC) panel located in the control room of the system building. The PLC is an extension of the controls for the ISVE system that are available at the main PLC and man-machine interface (MMI) located at the GWTP. The PLC is an Allen-Bradley SLC5/05 1747-L553 controller with Allen-Bradley 1746 Series Input/Output modules. It has a touchscreen interface that allows the user to observe key system parameters for the ISVE system and the thermal oxidizer system. The operation of the ISVE blower can be operated from either this location or from the GWTP MMI.

The control system located in the ISVE system building is connected to the GWTP PLC via a fiber optic cable that was installed in a two-inch diameter HDPE pipe that runs across the Off-Site Area to the GWTP.

2.2 STILL BOTTOMS POND AREA SYSTEM

The SBPA ISVE system consists of the following major components:

- Twenty-five ISVE wells
- Twenty-one DPE wells
- Six AS points
- Conveyance piping (for vapor and groundwater)
- Vacuum blower system
- Condensate removal system
- Extracted vapor treatment system
- Controls and Instrumentation

A process flow diagram for the SBPA ISVE System is included as Figure 11. An equipment index for the SBPA ISVE system is included as Table 2. The ISVE blower provides a vacuum at the ISVE wells and pulls the extracted vapors to the system building via the conveyance piping. In the system building, the individual conveyance pipes merge at a header system and are directed through the condensate removal system before entering the blower.

A knockout tank with a demister removes entrained water collected with the extracted vapors. The collected condensate water and the groundwater extracted by the DPE wells are pumped through a dedicated HDPE pipe to the GWTP for treatment.

The extracted vapors are then treated by the thermal oxidizer/scrubber system located at the GWTP to remove the contaminants from the vapor stream prior to discharge to the atmosphere. The thermal oxidizer heats the air stream to approximately 1,500 °F to combust the volatile contaminants of the vapor stream. Hydrochloric acid gas, a byproduct of the combustion process, is removed by the scrubber before the treated air is discharged to the atmosphere.

2.2.1 Wellfield

Figure 7 depicts the layout of the ISVE wells, DPE wells, and AS points in the SBPA. Construction details for all drilled points are summarized in Figure 7. Detailed drawings of typical ISVE, DPE wells and AS points are included on Figures 9 and 10.

The following subsections provide a description of each type of installed well.

2.2.1.1 ISVE Wells

Ten-inch diameter boreholes at each ISVE well location were drilled to the specified depth using 6¼-inch inside diameter hollow-stem augers. The ISVE wells were installed to depths ranging from ten to twenty-two feet bgs. Installation depths are included on Figure 7. The ISVE wells are constructed of four-inch diameter, 304 stainless steel riser pipes with a screen length of either five or fifteen feet. The screens have a slot size of 0.010 inches. The riser pipe for the wells extends approximately three to five feet above the ground surface.

A sand filter pack was installed from the bottom of the boring to one foot above the top of the screen. One foot of bentonite chips was installed above the filter pack and then hydrated. The chips were allowed to hydrate for approximately ten minutes to ensure the formation of a bentonite seal immediately above the filter pack. The remainder of the annular space was then filled with bentonite grout to the ground surface.

The riser pipes of wells in traffic areas were cut off approximately six inches below the top of the clay layer. A flush-mount wellhead including a manhole cover was then constructed over these wells.

2.2.1.2 Dual-Phase Extraction Wells

Boreholes 12¼-inch in diameter were drilled to the specified depth at the DPE well locations using 8¼-inch inside diameter hollow-stem augers. The DPE wells were installed to depths ranging from 10 to 22 feet bgs. Installation depths are included on Figure 7. The DPE wells were constructed of the six-inch diameter, 304 stainless steel riser pipes with a screen length of 15 feet. Upon construction completion, the riser pipe for the wells extended approximately three to five feet above the ground surface.

A sand filter pack was installed from the bottom of the borehole to one foot above the top of the screen. One foot of bentonite chips was installed above the filter pack and then hydrated. The chips were allowed to hydrate for approximately ten minutes to ensure the formation of a bentonite seal immediately above the filter pack. The remainder of the annular space was then filled with bentonite grout to the ground surface.

The riser pipes of DPE wells in traffic areas were cut off approximately six inches below the top of the clay layer to accommodate vehicular traffic in the SBPA. A flush-mount wellhead including a manhole cover was then constructed over these wells. A table included on Figure 7 differentiates wells as having either stick-up or flush-mount well completions.

Pipes were extended to the DPE wells to connect the submersible pumps to the GWTP. A three-inch diameter HDPE pipe was installed in a loop around the perimeter of the ISVE well field, near each DPE well, as shown in Figure 8. This three-inch diameter pipe loop connected to another pipe that delivers the extracted groundwater directly to the GWTP for treatment. A two-inch diameter HDPE pipe was installed between three DPE wells (SVE-61, SVE-63, SVE-65) located in the center of the well field. This two-inch diameter pipe is routed to the system building where it is connected to another pipe that leads to the GWTP.

2.2.1.3 Air Sparge Points

The AS points were driven to the target depth utilizing a disposable drive point attached to the casing. The AS points were installed to approximately 20 feet bgs to coincide with the base of the upper aquifer. The points were constructed of one-inch diameter, 304 stainless steel riser pipes with a screen length of two feet. The annular space was then filled with bentonite grout to the ground surface.

Upon operation of the AS points it was determined that air flow was not occurring in four of the six AS points. In August 2004, MWH removed the well casing and screen at AS-5 to determine the cause of flow blockage. The entire well screen plus approximately one-foot of the riser pipe above the screen was filled with silt and fine-grained sand. Thus it appears that fine-grained material flow migrated through the well screen and blocked the screened portion. A new sparge point with a larger slot size was installed in the same borehole. A pressure washer was used to remove sand and silt from the other three non-functioning AS points. Testing confirmed air flow at all AS points except the newly-installed AS-5. A portable air compressor was used to blow air into AS-5 to determine if the filter pack surrounding the well screen was clogged and preventing air flow. At 20 psi, a flow of 25 cfm was recorded. At 20 psi, a flow of 25 cfm was recorded, confirming that the casing and screen at AS-5 is intact and functional. In summary, after the August work was completed, all six AS points function as designed.

The flow rate in each well should be monitored periodically to ensure that they continue to function appropriately. Periodic cleaning of the AS wells may also be necessary to remove silt if the monitoring indicates that the air flow rate has been reduced significantly.

2.2.2 System Buildings

Two system buildings were constructed for the SBPA ISVE system. Building 1 houses the mechanical equipment associated with the ISVE system (e.g., vacuum blower, knockout tank, water transfer pump, and ISVE piping manifold). Building 2 houses the electrical and control equipment as well as the mechanical equipment associated with the AS system. The manifold for the DPE pump air supply system is also located in Building 2. Figure 12 depicts the layout of the system buildings.

Building 1 is a 32-foot long, 10-foot wide, 8½-foot high steel tube frame on a base frame made from 10-inch steel C-channels. The building has a ½-inch plywood interior, R13 insulation on the walls and ceiling, and exterior vinyl siding. The building is rated for potentially hazardous environments. Building 2 is constructed of the same materials as Building 1. Building 2 is 24-feet long, 10-feet wide, and 8½-foot high. Building 2 and its contents were not constructed for hazardous environments.

2.2.3 System Equipment

2.2.3.1 ISVE Blower

The ISVE blower is a 30-horsepower, positive displacement blower (Hibon Model No. H/V 815) rated for 1,000 cfm at a vacuum of 95" H_2O and a discharge pressure of 23" H_2O. Prior to startup, the critical blower parts were coated with an acrylic urethane coating to provide chemical and abrasion resistance. The lead time for delivery of this blower with the specified coating has typically been approximately six months.

2.2.3.2 Air Sparge Blower

The AS blower is a 7.5-hp, rotary vane pump (Becker Model No. KDT 3.80) rated for 30 cfm at a discharge pressure of 17.8 psi.

2.2.3.3 Knockout Tank/Pump

A 500-gallon (300-gallon fluid capacity) stainless steel knockout tank is located in Building 1. The tank has a removable top cover and an internal demister element. A sight glass installed on the exterior of the tank allows visual observation of the water level in the tank. A drain port with a manual ball valve is located near the base of the tank. A Magnetrol Eclipse-series level transmitter transmits the liquid level in the knockout tank to the PLC. The PLC uses the liquid level information to control operation of the transfer pump.

A Moyno-brand progressive cavity, explosion-proof pump with a one-horsepower motor is mounted next to the knockout tank. The pump transfers water from the knockout tank to tank T-102 located in the GWTP on command from the PLC.

2.2.3.4 Conveyance Piping/Manifold

A dedicated conveyance pipe was installed to connect each of the ISVE wells and AS points to the pipe manifold installed in the system building. The conveyance piping and pipe fittings installed below the ground surface include three-inch diameter (ISVE) and two-inch diameter (AS and water) SDR 11 Plexco Performance Pipe 1000 Series HDPE pipe. One-inch diameter pipe was also routed to the DPE wells to supply air to the pneumatic pumps installed at these locations. Figure 8 depicts the approximate locations of the conveyance piping.

The ISVE system piping manifold, located in Building 1, was constructed with six-inch diameter Schedule 80 PVC piping. The manifold is divided into two main headers (one on the north side and one on the south side of the building). The piping from each well, installed in the foundation slab, is connected to these main headers via three branches with another six-inch diameter pipe branch that can be used to introduce ambient air into the vacuum system. Six-inch diameter manual butterfly valves are located on each branch to control flow.

2.2.3.5 System Control Equipment

The SBPA ISVE System has a dedicated MCC and programmable logic control panel located in Building 2. The PLC is an extension of the controls for the ISVE system that are available at the main PLC and MMI located at the GWTP. The PLC is an Allen-Bradley SLC5/05 1747-L551 controller with Allen-Bradley 1746 Series Input/Output modules. It has a touchscreen interface that allows the user to observe key system parameters for the ISVE system and the thermal oxidizer system. The operation of the ISVE blower can be operated from either this location or from the GWTP MMI.

The control system located in the ISVE system building is connected to the GWTP PLC via a fiber optic cable that was installed in a two-inch diameter HDPE pipe that runs across the On-Site Area to the GWTP.

2.3 VAPOR TREATMENT SYSTEMS

The method selected to treat the extracted vapor is thermal destruction. The following sections discuss the equipment selected for this purpose. Detailed information including parts lists and maintenance procedures is included in the manufacturer-supplied operations and maintenance manuals stored at the site.

2.3.1 Thermal Oxidizer/Scrubber Systems

Two separate thermal oxidizer/scrubber systems are available for treating vapors: Thermal Oxidizer/Scrubber 1 (Therm Ox 1), manufactured by Durr Environmental, Inc. of Plymouth, Michigan and Thermal Oxidizer/Scrubber 2 (Therm Ox 2), manufactured by Global Technologies of Milwaukee, Wisconsin. Both thermal oxidizers are located outside of the south end of the GWTP building. Both scrubbers are located inside the GWTP building. The vapor conveyance header systems are configured such that either thermal oxidizer unit can accept vapors from either one or both ISVE systems, as well as vapors from the GWTP's aeration tank.

The header system is connected to a damper assembly adjacent to the inlet to the thermal oxidizer. The damper assembly includes a twelve-inch diameter fresh air damper and an eight-inch diameter isolation damper.

2.3.1.1 Thermal Oxidizer/Scrubber 1 (Durr)

<u>Thermal Oxidizer</u>

The thermal oxidizer rests on a structural steel skid fabricated from tube steel. The influent piping constructed of eight-inch diameter HDPE pipe runs below ground from the Off-Site Area and terminates at a manifold located in the southeast corner of the GWTP. The HDPE pipe is connected to the thermal oxidizer by eight-inch diameter PVC pipe. A Dwyer Model 2020 pressure gauge and a Dwyer Model 605 Magnehelic differential pressure-indicating transmitter with an averaging pitot tube assembly is located on the influent piping. The inputs from these instruments are used to control the speed of the variable frequency drive (VFD) and subsequently the process blower.

A condensate water knockout tank is located on the influent piping to remove any additional condensate from the vapor stream prior to entry into the thermal oxidizer. At the present time, an automatic method of removal of the condensate water collected in the tank has not been installed. The operator regularly checks the level in the tank to determine if removal of the condensate is needed. The operator then activates a pump to remove the condensate.

The influent pipe is connected to the damper assembly adjacent to the process blower. The damper assembly includes a six-inch diameter fresh air damper and an eight-inch diameter isolation damper. The dampers are controlled by electric actuators manufactured by Remote Control, Inc.

A forced draft process blower pushes air flow through the oxidizer/scrubber system. This blower is a 1,200-cfm, 7.5-hp American Fan Company blower with a 316L stainless steel impeller. The blower is controlled by a VFD that modulates the speed of the blower to maintain near static pressure in the influent piping.

A shell-and-tube heat exchanger preheats the process air before it enters the oxidizer's combustion chamber. The heat exchanger is constructed of ¾-inch diameter Inconel tubes through which the cool influent air flows. The exhaust air from the combustion chamber flows over the outside of the tubes.

The combustion chamber is constructed of 10-gauge Hastelloy C276 plate and stainless steel supports. The chamber is continuously welded for an airtight construction. It is lined with four-inch thick Harbison Walker Ultra Green 45 castable refractory and insulated with ¼-inch thick Therma-Fiber K-FAC SR hardboard.

The temperature in the combustion chamber is controlled by a natural gas burner system. The existing gas supply at the GWTP was extended to the location of the new thermal oxidizer. A flow meter showing total flow records the system's natural gas consumption. The temperature is maintained at the set point (typically 1,400°F to 1,700°F) by a Honeywell UDC1000 Micro-Pro controller. This controller modulates the firing rate of the Eclipse TJ100 burner through a series of control valves, regulating valves, and pressure switches on the gas train and by a modulating combustion air valve. The combustion air valve regulates air flow from the combustion blower to the burner. The combustion blower is a 250-cfm, 2-hp, American Fan Company blower. A Honeywell C7061 Ultraviolet Flame Detector verifies the existence and measures the strength of the flame.

A flanged connection was included on the oxidizer to allow a portion of the combustion chamber effluent air stream to bypass the heat exchanger. A duct with a valve connects the combustion chamber directly to the heat exchanger effluent duct. This allows the operator to increase, if necessary, the loading capacity of the chamber by reducing the amount of heat in the combustion chamber influent.

Thermocouples are installed in the combustion chamber and heat exchanger to monitor temperatures throughout the unit. The thermocouples are 12-inch long, Watlow Gordon dual-element thermocouples with an Alloy 600 sheath.

Scrubber

Heated air exits the oxidizer through an 18-inch diameter duct constructed of Hastelloy C276. Flow enters the scrubber system through the quench header where the temperature of the air is reduced by a spray bar constructed of AL6XN alloy. The spray bar is fitted with one 30-degree BETE Fog-brand spray nozzle.

The main structure of the scrubber is constructed of AL6XN alloy. A sump at the base of the structure stores recirculation water. Above the sump, the absorption column houses the packing media. The recirculation spray headers, makeup spray headers, mist eliminator and stack are installed above the absorption column.

A Goulds Model 3298 centrifugal pump circulates the water from the scrubber sump up to the recirculation spray headers and the quench spray header. Two recirculation spray headers are constructed of AL6XN alloy pipe and are fitted with a total of four 90-degree BETE Fog-brand spray nozzles. The spray pattern allows for a 50 percent overlap. The water is sprayed down through the tower where the hydrochloric acid gas is absorbed by the water. When originally installed, the scrubber tower was filled with packing media (316 stainless steel rings). The packing media was removed in April 2003 and replaced with multiple spray nozzles and a directional diffuser to convert the unit to a vortex-type scrubber. The nozzles and diffuser produce sufficient mist to ensure intimate mixing of the process air with the recirculation water.

The two makeup water spray headers (similar fabrication to the recirculation spray headers) are located near the top of the scrubber structure. These headers spray fresh water on the underside of the mist eliminator to remove the potential deposits. The mist eliminator is a Munters-brand, vane-style mist eliminator constructed of Inconel 625. It removes water droplets from the air stream prior to discharge of the treated air through the scrubber stack.

The system exhaust stack, mounted directly on the scrubber, is constructed of 12-inch diameter, AL6XN alloy pipe. The stack was installed to a height of 35 feet above grade, approximately four feet above the GWTP roof.

The water level in the sump is monitored by a Rosemount Analytical Model 3051 Smart differential pressure transducer. The sump has an overflow pipe located immediately below the quench header.

Recirculation flow is measured by a Rosemount Analytical Model 8800C Smart Vortex Water Flow Meter.

The byproduct hydrochloric acid transferred to the scrubber water is neutralized by the addition of sodium hydroxide via a LMI/Milton Roy caustic metering pump. This pump transfers the sodium hydroxide from the existing storage tank (Tank T-8). The pumping rate is controlled by a Rosemount Analytical Model 54e pH/ORP HART Analyzer/Controller. The pH analyzer (sensor) is mounted in an isolated pipe loop.

The continuous neutralization of the hydrochloric acid in the scrubber water produces sodium chloride. The concentration of sodium chloride is measured by a Rosemount Analytical Model 54e C Conductivity/Resistivity Analyzer/Controller. When this concentration rises above a setpoint, the controller directs a solenoid valve to open, releasing water from the scrubber system to the gravity phase separator tank (T-101) where it enters the treatment process of the GWTP. This is called the blowdown process. The volume of blowdown water is tracked by a totalizing flow meter. Makeup water is added to the scrubber via another solenoid valve. The effluent water from the GWTP is used as makeup water in the scrubber unit.

Similar to the thermal oxidizer, the temperature in the scrubber is measured by a 12-inch long, Watlow Gordon dual element thermocouple with an Alloy 600 sheath.

2.3.1.2 Thermal Oxidizer/Scrubber 2 (Global)

Thermal Oxidizer

An induced draft system fan pulls air flow through the oxidizer/scrubber system. The fan has a 3,740 cfm capacity, with a 30 hp motor at 1,800 revolutions per minute (rpm) and was manufactured by Ceilcote. The fan is controlled by a VFD that modulates the speed of the blower to maintain near static pressure in the influent piping.

A shell-and-tube heat exchanger preheats the process air before it enters the oxidizer's combustion chamber. The heat exchanger is constructed of Alloy 600 steel tubes through which the cool influent air flows. The exhaust air from the combustion chamber flows over the outside of the tubes.

The combustion chamber is constructed of carbon steel. The interior side of the carbon steel shell is coated with a corrosion-resistant Thortex coating. The interior of the reactor is lined with nine inches of ceramic fiber insulation anchored with Hastelloy pins.

The temperature in the combustion chamber is controlled by a natural gas burner system. The temperature can typically range from 1,400 ^{o}F to 1,700 ^{o}F. The temperature is maintained at the set point by a Honeywell controller. This controller modulates the firing rate of the Maxon burner through a series of control valves, regulating valves, and pressure switches on the gas train and by a modulating combustion air valve. The combustion air valve regulates air flow from the combustion fan to the burner. The combustion fan is a 600-cfm, 5-hp fan manufactured by Twin City Fan.

Thermocouples were installed in the combustion chamber and heat exchanger effluent to monitor temperatures throughout the unit. The thermocouples are 12-inch long dual-element thermocouples and 48-inch triple-element thermocouples manufactured by Pyromation.

Scrubber

Heated air exits the oxidizer through a 22-inch diameter duct constructed of Hastelloy C276. The air enters the scrubber system through the quench header where the temperature of the air is reduced by water spray from three spray bars constructed of Hastelloy.

The main structure of the scrubber is constructed of fiberglass-reinforced plastic (FRP). A sump at the base of the structure stores recirculation water. The tower above the sump contains the packing media (Ceilcote Tellerette Type K#2 chlorinated polyvinyl chloride (CPVC) spheres) and contains a polypropylene demister to remove entrained water droplets. The packing ensures intimate mixing of the process air with the recirculation water.

A three-hp Ansimag centrifugal pump circulates the water from the scrubber sump up to the quench spray header and the recirculation spray headers, installed above the packing media. The water is sprayed down across the top of the packing media where the hydrochloric acid gas is absorbed by the water.

The main blower is installed on a platform constructed above the scrubber. The system stack is also mounted on the platform and extends vertically through the roof of the GWTP. The system exhaust stack, is constructed of 18-inch diameter, FRP pipe. The stack was installed to a height of 35 feet above grade, approximately six feet above the GWTP roof.

The water level in the scrubber sump is monitored by a Magnetrol Kotron RF Sensing Probe. The sump has an overflow pipe located immediately below the quench header. Recirculation flow is measured by a Hayward Series 2000 flow sensor.

The byproduct hydrochloric acid transferred to the scrubber water is neutralized by the addition of sodium hydroxide via a Milton Roy caustic metering pump. This pump transfers the sodium hydroxide from the existing storage tank (Tank T-8). The pumping rate is controlled by a variable 4-20 milliamp (mA) signal Great Lakes Instruments (GLI) pH transmitter. The pH analyzer (sensor) is mounted in an isolated pipe loop.

The continuous neutralization of the hydrochloric acid in the scrubber water produces sodium chloride. The concentration of sodium chloride is measured by a GLI Conductivity Sensor. When the sodium chloride concentration rises above the setpoint, the PLC directs a solenoid valve to open, releasing water from the scrubber system to the gravity phase separator tank (T-101) where it enters the treatment process of the GWTP. This is called the blowdown process. The volume of blowdown water is recorded by a totalizing flow meter. Makeup water is added to the scrubber via another solenoid valve. The effluent water from the GWTP is used as makeup water in the scrubber unit.

Similar to the thermal oxidizer, the temperature in the scrubber is measured by a 12-inch long, Pyromation dual element thermocouple and reported to the PLC.

2.4 INTERACTION WITH GWTP

Both ISVE systems have dedicated PLCs and MCCs located in the system buildings. The PLCs are connected to the GWTP PLC via fiber optic lines. Each is an extension of the controls for the ISVE system that are available at the main PLC and MMI. The PLCs have touchscreen interface that allows the user to observe key system parameters for the ISVE system and the vapor treatment systems.

Both vapor treatment systems have dedicated PLCs mounted inside the GWTP. The PLCs control operation of the individual vapor treatment systems and communicate operational information to the GWTP PLC.

2.4.1 Interlocks

Operation of the thermal oxidizer/scrubber systems are interlocked with the operation of the ISVE blowers and components. Included below is a general description of the interlocks associated with the ISVE systems.

The Off-Site Area ISVE system has a solenoid valve installed on the ambient air influent pipe. It is also equipped with a manually controlled valve. The SBPA ISVE system is only equipped with a manually controlled valve. The ambient air influent pipes can be used to mix fresh air with the vapor stream, thus allowing further control of the vapor concentrations that are delivered to the thermal oxidizer. The solenoid valve is opened for a one-minute period upon startup of the ISVE blower. This allows the thermal oxidizer to receive a gradual increase in vapor concentration.

The solenoid valve is directed to open when the chamber temperature in the thermal oxidizer reaches a certain value. This value can be inputted and altered by the operator through the MMI computer in the GWTP. The inputted value is generally set at a point below the critical shutdown temperature.

The operation of the condensate pumps is interlocked with the GWTP PLC. Each pump delivers the condensate collected in its respective knockout tank to the equalization/aeration tank at the GWTP. The pump is not allowed to operate when the high-level switch, LH7-102, in the equalization/aeration tank is activated. The pump will also not operate when the GWTP PLC indicates a general shutdown condition or alarm.

Operation of the condensate pumps is controlled by water level monitors installed in the knockout tanks. The pump is activated when the high water level value is reached and deactivated when the water level drops to the low water level value.

If the water level in a knockout tank reaches the high-high level, the corresponding ISVE system blower is deactivated. An ISVE blower is also shut down when the blower effluent pressure increases above a certain value (inputted by the operator at the MMI). When the ISVE blower is shutdown, the thermal oxidizer/scrubber system immediately switches to "hot idle" operation mode.

Startup of the ISVE blower is contingent on the status of the thermal oxidizer. Upon "ready-to-treat" status (process temperature reached) of the thermal oxidizer, a permissive to run is given to the ISVE blower.

The SBPA ISVE system integrates water extraction pumps at 21 ISVE well locations. These wells are called DPE wells. An interlock links the PLC with operation of these DPE well pumps. The pumps will not operate when the high-level switch, LH7-102, in the equalization/aeration tank is activated or when there is a general shutdown or alarm in the GWTP.

2.4.2 Scrubber Makeup Water Supply

The water used for makeup water in the scrubber is GWTP effluent water that is run through a GE Osmonics E4H-21K-ECN-50 Reverse Osmosis Machine to remove hardness.

2.4.3 Heat Exchanger to Activated Sludge Plant

During winter months, the scrubber water is an important source of heat for maintaining a desired temperature of the water in the activated sludge plant (ME-101). To accomplish this, a dedicated pump has been added to scrubber associated with ThermOx 2. This pump diverts a portion of the hot scrubber water and transfers it through a heat exchanger located in Tank T-2 (part of the GWTP). The effluent from the heat exchanger is then returned to the scrubber. The water in Tank T-2 flows to the activated sludge plant. The heat exchanger was manufactured by Omega Products.

3.0 SITE ACCESS

Security measures have been implemented to minimize the possibility for unauthorized entry to the extraction and treatment facilities. To control access, the access road to the Off-Site Area ISVE system is blocked by a locked chain-link fence and gate with barbed wire. The SBPA ISVE system is located within the ACS operating facility which is blocked by a locked chain-link fence. The treatment facility is housed inside a building that will remain locked at all times when no operating personnel are present. The main entrance to the building will remain closed to prevent unauthorized entry. Personnel entering the GWTP building will park outside the building and will not be allowed to enter the building until signing in with the operations personnel. A sign stating "Warning - Unauthorized Personnel Keep Out," is posted at the building entrance. A set of keys to the building will be kept by the following people:

- Site Safety Officer (SSO)
- Lead Operator
- Operations Manager

The SSO, Lead Operator, and Operations Manager also have a key that allows access to the ACS operating facility. An additional set of keys is secured in a lock box located in the office within the GWTP. Only the SSO, Lead Operator, Operations Manager, and a Field Technician (Tim Kirkland) have a key allowing access to the lock box.

If there has been a security violation, the Project Manager (PM) will be notified immediately. The PM will be responsible for initiating response measures. The operations personnel will prepare a written statement describing the events of the security violation and submit the statement to the PM. The report content will include the nature of security violation, approximate time period of the event, impact of security violation on the facility, and if a facility shut down may be required.

Key project personnel are listed below:

Contact Name	Project Role	Business Phone	Residence Phone
Peter Vagt	Project Manager	(312) 831-3466	(630) 665-4629
Lee Orosz	Site Safety Officer/ Supporting Operator	(219) 924-4607	(219) 947-5228
Lee Orosz	Lead Operator	(219) 924-4607	(219) 947-5228
Robert Adams	Engineering Manager	(312) 831-3406	(630) 761-3261
Todd Lewis	Operations Manager	(312) 831-3478	(708) 424-0891

The following describes the role and responsibilities of key personnel assigned to GWTP operation and maintenance.

3.1.1 Project Manager

As PM, Dr. Peter Vagt, P.G. will have the overall responsibility for the GWTP and ISVE O&M activities, for assigning field personnel and interacting with the operations staff on a regular basis, and for ensuring that all activities are conducted in a safe manner and in accordance with approved documents. He will also be responsible for communicating information to the ACS Steering Committee and the regulatory agencies Project Coordinators per a mutually agreed-upon schedule.

3.1.2 Site Safety Officer

Mr. Lee Orosz is responsible for maintaining proper medical surveillance, providing hazard communication information, training employees in safe operating procedures, and advising the PM on matters concerning the health and safety of the employees or the public. The SSO may be required to perform various types of area or personnel monitoring for purposes of determining worker exposure and proper selection of personal protective equipment (PPE) if unforeseen chemical hazards are encountered. The SSO should be consulted when any changes in the recommended procedures or levels of PPE are made.

3.1.3 Lead Operator

Mr. Lee Orosz will be the lead operator responsible for day-to-day operations of the GWTP and ISVE systems. In this capacity, he will be responsible for ensuring that the system components work as designed and that the extraction and treatment facilities operate in accordance with the design criteria. He will also be responsible for the facility maintenance including scheduled and unscheduled equipment maintenance, replacement parts ordering and stocking, facility start up and shut down, on-site analytical work, and preparation of the operation logs.

3.1.4 Engineering Manager

Mr. Robert A. Adams, P.E. is responsible for the execution and administration of all engineering-related activities at the GWTP and ISVE systems. Primary responsibilities include development of operational procedures and updating the procedures as needed, incorporating changes to the facility design to enhance the system performance, preparation of agency submittals to document changes and additions, and for ensuring that the sampling and analysis plan is implemented per the approved documents.

3.1.5 Operations Manager

Mr. Todd Lewis is in charge of the operations and maintenance of the GWTP and ISVE system. In this capacity, Mr. Lewis will direct the lead operator for day-to-day activities, coordinate with SSO to ensure safe operating environment, and advise the PM on matters concerning the facilities operation. He will also interact with the Project Manager and Engineering Manager during implementation of changes to the system design.

4.0 SYSTEM OPERATION

4.1 STARTUP PROCEDURES

- This section provides a description of the procedures that should be followed during the startup of the ISVE Systems. The procedures for startup for both the Off-Site and the SBPA are generally the same. Differences between the two systems are noted. The startup of the system can be divided into three general areas: pre-operational checks, thermal oxidizer/scrubber startup, and ISVE system startup.

4.1.1 Pre-Operational Checks

Prior to startup of the ISVE systems, the following checks should be performed:

1. Confirm that the caps on all of the ISVE and DPE wells are secured.

2. At the system buildings, confirm that each of the header valves is in the correct position. Confirm that the appropriate valves on the individual risers are open.

3. Confirm that the valves on the header system are configured to allow vapors from each ISVE system to be delivered to the appropriate vapor treatment unit. The configuration of the valves should be coordinated with the "Vapor Source" screen at the MMI computer. This screen interlocks the ISVE system operation with the operation of the thermal oxidizer that is receiving the vapors. (Note: if any of the vapor treatment units are in service, the corresponding box on the right-hand side of the Vapor Source screen should be checked to ensure vapors cannot be accidentally sent to an idle unit.)

4.1.2 Thermal Oxidizer/Scrubber Systems Startup

After the pre-operational checks have been conducted, the thermal oxidizer/scrubber system can be started.

1. Activate the oxidizer system by pressing the start button (green button on the ThermOx 1 panel or touch-key on ThermOx 2 control screen).

2. For ThermOx 1, confirm the burner voltage (as displayed on the flame controller inside the control panel). The voltage should be 5.0 volts. After approximately one minute, if this value is not displayed, push the reset button on the control panel and attempt startup again.

3. Observe the chamber temperature to ensure it is rising. The time necessary for ThermOx 1 to warm up from ambient temperature to 1,000°F is typically four to five hours. An additional four hours is necessary for ThermOx 1 to increase the chamber temperature from 1,000°F to 1,500°F ("hot idle" temperature). ThermOx 2 is capable of reaching "hot idle" temperature in one or two hours.

4. While the chamber temperature is increasing, check the scrubber water conductivity and pH as detected by the sensors installed on the scrubbers. Normal range for pH is from 4 to 6. If the pH is higher than the normal range, a portion of the water should be flushed out into the GWTP sumps and replaced with makeup water (effluent water from the GWTP). If the pH is lower than the normal range, a pump linked to a pH probe will automatically meter caustic into the scrubber water until the normal range is achieved. Normal range for conductivity should be approximately 1 to 3 microSiemens per centimeter (mS/cm). If the conductivity is higher than the normal range, a portion of the water in the scrubber should be flushed out into the GWTP sumps and replaced with makeup water from the GWTP. If this is not successful in decreasing the conductivity, the probe should be recalibrated.

5. Once the chamber temperature has reached "hot idle" temperature (typically 1400°F to 1500°F), the oxidizer sends a permissive to the GWTP PLC to allow operation of the ISVE systems. This permissive signal is displayed with a "READY" signal on the ISVE screens at the MMI computer and in the PLCs located in the system buildings.

6. The thermal oxidizer is now ready to receive vapors from the ISVE system(s).

4.1.3 ISVE System Startup

Once the thermal oxidizer is in "hot idle" mode and the permissive signal is received at the GWTP PLC, the ISVE systems can be activated.

1. Press the "START" button at the MMI computer at the GWTP or in the system buildings.

2. Observe the status of the dilution air valve and the process valve on the thermal oxidizer as displayed on the MMI computer. Once flow is confirmed by the system, these valves should both change positions (dilution air closes, process valve opens). If process valve is closed, immediately shut down ISVE blower.

3. Observe the chamber temperature as the vapor stream is delivered to the thermal oxidizer. The temperature may drop initially due to colder ambient air with little contaminant vapors is delivered but should increase as the contaminant loading is increased. The chamber temperature should settle at or near the process temperature.

4. If the ISVE blowers shut down within the first ten seconds, it may be due to excess condensation located in the conveyance pipe between the system building and the thermal oxidizer. This condensation can be "pushed" out of the pipe by repeatedly starting the blower. The condensed water is sent either directly to the combustion chamber (ThermOx 2) or through a redundant knockout tank located at the GWTP (ThermOx 1).

5. During blower operation, ensure the vacuum on the blower influent line does not exceed 95" H_2O (maximum operating condition for blower per Fliteway).

6. Adjust gate valves to the wells to evenly divide the flow between them. This will eliminate preferential flow from individual wells.

4.2 SHUTDOWN PROCEDURES

The following procedures should be followed when shutting the ISVE system and vapor treatment units (if necessary) down.

1. Push the "STOP" button on the MMI screen to deactivate the ISVE blower.

2. Observe the status of the dilution air valve and the process valve on the thermal oxidizer as displayed on the MMI computer. These valves should both change positions (dilution air opens, process valve closes).

3. Deactivate the oxidizer system by pressing the start button (red button on the ThermOx 1 panel or touch-key on ThermOx 2 control screen).

4. Observe chamber temperature and system flow decrease.

If the ISVE system is to be out of operation for an extended period of time (longer than one week), close the header valves in the system buildings. This will prevent vapors from accumulating in the conveyance line between the system building and the GWTP.

5.0 MAINTENANCE PLAN

5.1 SPARE PARTS MANAGEMENT

Critical spare parts should be maintained for each major piece of equipment for the ISVE systems. Table 3 provides an inventory of recommended spare parts based on the equipment manufacturer's recommendation. Equipment manufacturers' manuals for the ISVE systems are included in the *Off-Site Containment Area and K-P Area In-Situ Soil Vapor Extraction Systems Construction Completion Report* and the *Still Bottoms Pond Area In-Situ Soil Vapor Extraction System Construction Completion Report.* Stand-alone manuals for the two thermal oxidizer units are also present onsite. Additional manufacturers' manuals and as-built drawings for the GWTP are included as Volumes 4-11 of the Operations and Maintenance Manual for the Groundwater Treatment Plant. These documents may be found in the GWTP office.

When establishing the initial spare parts list, the operator should assemble an inventory of special tools to ensure the proper tools are used when performing the required maintenance procedures.

5.2 PREVENTATIVE MAINTENANCE

Preventive maintenance is the most crucial program to ensure proper, long-term operation of the system components. It involves service maintenance tasks to prevent or minimize process shut down, to reduce wear on all equipment, and to extend the useful life of equipment and structures.

Refer to the equipment manufacturer's literature for further information regarding preventive maintenance requirements. The maintenance should be conducted by trained and authorized personnel in accordance with the equipment manufacturer's recommendations.

5.2.1 Initial Functional Tests

New vessels, fittings, and piping should be leak-tested with compressed air to confirm that there are no leaks. Following leak testing, repairs should be made as necessary and the equipment and piping should be retested to ensure the leaks have been properly repaired. The utility supply lines should also be tested when new components are added.

After the treatment system has been checked for leaks and the necessary repairs have been made, a functional test should be conducted on each process unit. Functional tests on new equipment should be conducted using compressed air. New and existing controls, alarms, valves, pumps, and motors should be verified for proper function. The purpose of the functional tests on the new equipment is to ensure that the equipment and all of its components were installed and operate properly. This is important because existing process components may serve a different role with the addition of new process components.

5.3 ROUTINE MAINTENANCE

Routine maintenance involves the care of mechanical equipment. Routine maintenance of the mechanical equipment should be conducted as needed or as specified by the individual equipment manufacturers.

5.4 CORRECTIVE MAINTENANCE

Corrective maintenance is the work required to repair major equipment malfunctions including complete overhauls and emergency repairs. Maintenance personnel should be constantly prepared to handle this type of emergency work to ensure continuity of the system operation.

A major item of concern with the execution of corrective maintenance is that these maintenance tasks are generally more complex, thereby requiring more expertise and mechanical aptitude to complete the job that in-house personnel can provide. The operator must determine if the work needed to be done can be accomplished by in-house personnel or must be contracted out to a specialized service contractor.

5.5 GENERAL MAINTENANCE REQUIREMENTS

Maintenance requires considerable skill acquired by experience, study, and practice. The maintenance programs should incorporate a good housekeeping program and should serve the following rules:

- Keep a clean, neat, and orderly operating facility.
- Establish a systematic plan for the execution of regular operations.
- Establish a routine schedule for inspections and lubrications and update the schedule based on past system operation.
- Keep data and records of each piece of equipment, with emphasis on unusual incidents and faulty operating conditions.

Performance of the day-to-day maintenance functions is only one obligation of maintenance personnel. There is the obligation of record keeping on each individual piece of equipment. This record keeping is to include all work performed on that particular unit, along with comments on the overall condition and operating characteristics. Analysis of these records assists in the detection of an impending failure of the piece of equipment and subsequent scheduling of its repair in a timely manner.

6.0 PROCESS MONITORING

MWH follows a monitoring plan to evaluate system performance and to determine optimum operating conditions for the conditions for the ISVE systems. The focus of the process monitoring is to gather vapor and groundwater data and to perform routine maintenance on equipment. The monitoring plan presented here involves collecting vapor flow, pressure, and VOC concentrations at individual ISVE wells as well as water levels. It also includes collecting influent and effluent samples from the therm-ox units to monitoring ISVE system performance and ensure compliance with the Indiana Department of Environmental Management (IDEM) air emission requirements.

The data will be used primarily for trend tracking; therefore, it is extremely important that consistent protocols and equipment are utilized to reduce variances caused by differences in sampling methods or procedures. Blank field forms for recording the data in the field have been included in Attachment 1.

Information presented in this monitoring plan is based on the Quality Assurance Project Plan (QAPP), the 1999 Field Sampling Plan Addendum, the 2002 Operations and Maintenance Manual for the Groundwater Treatment Plant, and 1999 Field Sampling Plan Addenda. These documents should be used in conjunction with this O&M manual.

6.1 VAPOR MONITORING

Vapor monitoring is conducted at the well headers located inside the system buildings. Vacuum/Pressure, flow rate, and VOC concentrations are collected at the well headers and main headers inside the system building.

The following equipment is used during vapor monitoring:

- Vacuum pump
- Magnehelic gauges
- Photo-ionization detector (PID)
- Tygon tubing

Follow the recommended procedures as specified by the manufacturer for equipment calibration and operation. *The PID should be calibrated before each use (per manufacturer recommendations).*

Listed below is a step-by-step procedure for collection of vapor monitoring parameters:

1. **Record Vacuum/Pressure:** Obtain vacuum readings from vacuum gauges mounted on each well header. Record readings at each well (active and inactive). If vacuum is

near zero, attach Dwyer Magnehelic gauge (Range 0-100" H_2O) to sample port and record. This gauge will provide more accurate measure of low vacuums and pressures. Because these vacuums from the inactive wells will likely be low, the Dwyer Gauge should be used.

2. **Collect Sample:** Attach the vacuum pump to the sample port installed on each pipe with Tygon tubing. Run the pump at least one minute to ensure vapor desorption/adsorption are at equilibrium. Collect a sample of vapor from the pump effluent into a Tedlar bag. Fill and purge the Tedlar bag at least once prior to collecting the sample.

3. **Record VOC concentration:** Connect the Tedlar bag to the flame-ionization detector (FID)/PID meter and record VOC concentration.

4. **Record Differential Pressures:** Check for water in the magnehelic tubing. If present remove tube from magnehelic to drain. (Results will be inaccurate if water is present). Record the differential pressure using the pitot tube and Magnehelic gauges in each active ISVE well header. Insert the pitot tube into the well header. (The end of the pitot tube should 1/16" from the back of the pipe to ensure an adequate reading.) Record differential pressures at each main header.

5. **Adjust Flow Rates:** If flow from any one well is at or near zero, flows across the active wells are not adequately balanced. Adjust the flow rate from each well. Vacuums will vary. As remediation proceeds, the PM may elect to increase air flow rates from recalcitrant areas of the site. This decision will be based upon most recent vapor and soil data. Ambient air dilution should be minimized to maximize air flow from the wells.

6. **Record Weather Information:** Record ambient temperature, atmospheric pressure, and humidity. This information is critical to converting the differential pressures into flow rates. Readings can be obtained from www.weather.com. Also, note general weather conditions.

6.2 GROUNDWATER MONITORING

Groundwater elevations are used to evaluate the potential impact to ISVE operation. The Performance Standard Verification Plan (PSVP) requires groundwater level data to be recorded regularly at 14 ISVE wells in the Off-Site Area and 15 ISVE wells in the SBPA.

The following equipment is used during groundwater monitoring:

- Interface Probe

Procedures for the measurement of groundwater within source contaminant areas at the site were summarized in a June 26, 2003 memorandum. A copy of this memorandum is included as Attachment 2.

6.3 EQUIPMENT MONITORING

Equipment monitoring is important for evaluation of the performance of the system equipment. Utility (electricity, natural gas) usage rates, system flowrates, and discharge rates can be tracked to allow the operator to identify opportunities for system enhancement.

6.3.1 ISVE System Equipment

The following parameters should be recorded regularly:

- Vapor stream temperatures before and after ISVE blower
- Differential pressure across filter
- ISVE blower discharge pressure

As a precaution, the PID should be used to periodically monitor the atmosphere inside the system building to ensure that vapors are not escaping from the manifold system. If vapors are noted, target the source of the leak and remedy before continuing. It may be necessary to shut down the system, while correcting any problems.

6.3.2 Thermal Oxidizer/Scrubber

The following parameters should be recorded regularly:

- Flow rate
- Influent temperature
- Combustion chamber temperature
- Effluent temperature
- Natural gas volume (both temperature-corrected and non-compensated)
- Scrubber blowdown volume

As a precaution, the PID should be used to periodically monitor the atmosphere around the thermal oxidizer and scrubber units to ensure no leaks are present.

6.4 ANALYTICAL SAMPLING

Vapor samples for laboratory analysis will be collected monthly from (1) combined vapor flow from the ISVE wells (taken at the thermal oxidizer influent header at GWTP) and a duplicate, and (2) effluent flow from the thermal oxidizer. The samples will be collected via Summa canisters (evacuated canisters) and absorptive media and submitted to the laboratory for VOC and SVOC analysis via United States Environmental Protection Area (U.S. EPA)

Method TO-14 and TO-13. Collection of the effluent sample will not be required when the thermal oxidation treatment process is not operational.

Follow the procedures outlined in Air Toxics' *Guide to Air Sampling and Analysis* and *Guide to Sorbent-Based Sampling Volatiles and Semi-Volatiles* (Attachment 3).

6.5 RECORD-KEEPING

6.5.1 Monitoring Forms

The details of operations are to be summarized and recorded using the monitoring forms. The forms are used to record the time of the day, activities that took place, any sampling and analytical results, visual observations, and any calculations. The forms will also serve as a reminder of routine activities and inspections to be conducted.

Copies of the monitoring forms are included with in Attachment 1.

6.5.2 Operational Log

The operator for the extraction and treatment facilities should maintain a bound diary/journal-type logbook or computer document file. Log entries of various activities and problems should be made as they develop so that no items are overlooked.

The following items, at a minimum, should be noted in the logbook:

- Typical instrument readings,
- Startup or shutdown of equipment,
- Occurrence of accidents,
- Major breakdowns,
- Commencement and completion of major maintenance efforts,
- Chemical deliveries,
- Changes in operation, and
- Monitoring sampling.

Data monitored by the PLC will be electronically maintained by the MMI for 90 days. Printouts of this data may be incorporated by reference into the logbook.

6.5.3 Summary Records

A summary record is useful in identification of operational trends and forecasting of problems. For most operations, a monthly log arranged in the chronological order and showing equipment performance, chemical consumption, and other facility activities should be included in the summary records. The project engineer should decide the format and frequency of compilation of the summary records.

Data monitored by the PLC will be electronically maintained by the MMI for 90 days. Printouts of this data may be incorporated by reference into the monthly log.

6.5.4 Cost Records

The maintenance of complete cost records is valuable for use in the budgeting and planning efforts. The costs should include utility usage, chemical and shipping costs, equipment rental, and usage costs. Records defining the allocations and costs of labor for the facility should also be maintained.

6.5.5 Compliance Monitoring Reports

At the current time, compliance monitoring reports must be prepared and submitted to the regulatory agencies on a quarterly basis. In addition, summaries of the water level data and influent and effluent sample data will be forwarded to the agencies on a monthly basis in the monthly status report (subject to change by agreement from the Agency). The engineering manager or project manager will prepare and submit the quarterly reports, but the operators must provide the information required in accordance with the PSVP along with the progress reports.

6.6 LABORATORY REPORTS

Proper performance and interpretation of laboratory analyses will enable the operations staff to maximize efficiency and effectiveness of the various unit processes and each ISVE system as a whole. Laboratory analyses are also performed to ascertain whether or not compliance with the off-gas emissions standards are being achieved; such results shall be reported to the U.S. EPA and the IDEM in accordance with the PSVP and QAPP (MWH, November 2001).

The reporting program requires an adequate record keeping plan in order to maintain credibility. The following are recommended record keeping guidelines.

6.6.1 Sample Logs

Before a sample is collected, a significant amount of planning must be performed. The tool utilized to structure this planning is a sample log. Through a sample log the sample stream, collection time and method, mode of preservation, and analysis schedule can all be predetermined, and all quality assurance requirements can easily be fulfilled.

A sample log will be completed for each sample acquired:

- Sample type (compliance, process, etc.)
- Sample name and/or flow stream;
- Type of sample (grab or composite);
- Date and time of collection;
- Sampling location;
- Analyte(s) or analytical method(s); and,

The sample logs will be maintained electronically in a computer database.

6.6.2 Chain-Of-Custody

The chain-of-custody (COC) procedures allow for the tracing of possession and handling of individual samples from the time of field collection through laboratory analysis. Documentation of custody is accomplished through a COC record that lists each sample and the individuals responsible for sample collection, shipment, and receipt. A sample is considered in custody if it is:

- In a person's possession
- In view after being in physical possession.
- Locked or sealed so that no one can tamper with it after having been in physical custody.
- In a secured area, restricted to authorized personnel.

A COC form will be used to record the samples collected and the analyses requested. Information recorded will include time and date of sample collection, sample number, the type of sample, the sampler's signature, the required analysis, and the type of containers and preservatives used.

A copy of the COC record will be retained by the sampler prior to shipment. Shipping receipts will be signed and filed as evidence of custody transfer between field sampler and courier, and the courier and laboratory.

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TABLES

Table 1
Equipment Index - Off-Site ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

Location	Description	Manufacturer	Model	Vendor	Contact
SVE Stickup Well	4" dia. SS well casing	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
SVE Stickup Well	4" dia. SS well casing with 0.010" screen	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
SVE Stickup Well	4" x 3" dia. SS pipe saddle	NA	JCM 438 Tapping Sleeve	Forrer Supply Company	(800) 255-1030
SVE Stickup Well	3" dia. SS pipe nipple	NA	NA	Forrer Supply Company	(800) 255-1030
SVE Stickup Well	3" dia. SS NPT pipe flange	NA	NA	Forrer Supply Company	(800) 255-1030
SVE Stickup Well	3" dia. SDR 11 HDPE pipe flange adapter with SS backup ring	NA	NA	Forrer Supply Company	(800) 255-1030
SVE Stickup Well	Expandable test plug	NA	Monitor Well Plugs	USA Blue Book	(800) 548-1234
SVE Stickup Well	3" dia. SDR 11 HDPE vapor conveyance piping	Chevron Phillips	DriscoPlex 4100	NA	NA
Air Sparge Well	2" dia. SCH 40 SS well casing	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
Air Sparge Well	2" dia. SCH 40 SS well casing with 0.020" screen	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
Air Sparge Well	2" x 2" SS tee	NA	NA	Forrer Supply Company	(800) 255-1030
Air Sparge Well	2" brass ball valve	USA Blue Book	Stock #16952	USA Blue Book	(800) 548-1234
Air Sparge Well	2" dia. SS compressed air supply pipe	NA	NA	Forrer Supply Company	(800) 255-1030
Air Sparge Well	2" dia. SS NPT pipe flange	NA	NA	Forrer Supply Company	(800) 255-1030
Air Sparge Well	2" dia. SDR 11 HDPE pipe flange adapter with SS backup ring	NA	NA	Forrer Supply Company	(800) 255-1030
Air Sparge Well	Expandable test plug	NA	Monitor Well Plugs	USA Blue Book	(800) 548-1234
Piping to Building 1	3" dia. HDPE vapor conveyance pipe	Chevron Phillips	DriscoPlex 4100	NA	NA
Piping to Building 1	1" dia. HDPE compressed air supply pipe	Chevron Phillips	DriscoPlex 4100	NA	NA
Piping to Building 1	SS/HDPE transition fitting	NA	NA	Forrer Supply Company	(800) 255-1030

MBM/JDP/CAD/jmf
J:\209\0601 ACS\0301 Engineering for O\ISVE Systems O Manual\Parts List_rev2.xls\Table 1 - Off-Site System

Table 1
Equipment Index - Off-Site ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

Location	Description	Manufacturer	Model	Vendor	Contact
System Building Utilities	Wall mounted ventilation fan with louvered vents	New York Blower Co.	EN122	Fliteway Technologies	(800) 236-3580
System Building Utilities	Thermostat (rated for hazardous locations)	Columbus Electric	EPETD8D	Fliteway Technologies	(800) 236-3580
System Building Utilities	Electrical convection heater	Dayton	FEP-3648-1RA or 3UG73	Fliteway Technologies	(800) 236-3580
System Building Utilities	150 W light (rated for hazardous locations)	Hubbel/Killark	V Series Lighting, Fixture Type 100	Fliteway Technologies	(800) 236-3580
System Building Pipe	3" clear flexible PVC connector pipe	NA	NA	J&L Fasteners	(219) 845-8500
System Building Pipe	6" dia. SCH 80 PVC header pipe	NA	NA	Forrer Supply Company	(800) 255-1030
System Building Pipe	1" dia. galvanized air supply pipe (for air sparge wells)	NA	NA	Forrer Supply Company	(800) 255-1030
System Building Pipe	2" dia. galvanized manifold pipe (for air sparge wells)	NA	NA	Forrer Supply Company	(800) 255-1030
System Building Pipe	6" silencer	Universal Silencer	U5-6	Fliteway Technologies	(800) 236-3580
System Building Pipe	Ambient air silencer	Universal Silencer	Lil Hummer CB-6	Fliteway Technologies	(800) 236-3580
Valves & Fittings	6" bronze butterfly regulator valve for SVE header system	W.E. Anderson	MBVL 1206	Dwyer Instruments	(219) 879-8000
Valves & Fittings	3" PVC knife gate valve (SVE riser pipes)	Valterra	Stock #18251	USA Blue Book	(800) 548-1234
Valves & Fittings	6" dia. check valve	Spears	No. 4423-060	USA Blue Book	(800) 548-1234
Valves & Fittings	3" dia. Ambient bypass valve	Asahi/America	Series 94	USA Blue Book	(800) 548-1234
Valves & Fittings	Vacuum relief valve	Kunkle Valve Division	215V	Fliteway Technologies	(800) 236-3580
Valves & Fittings	Pressure relief valve	Kunkle Valve Division	337	Fliteway Technologies	(800) 236-3580
Gauges & Measurement Devices	Vacuum gauge	Dwyer Instruments	NA	Dwyer Instruments	(219) 879-8000
Gauges & Measurement Devices	Temperature gauge	Dwyer Instruments	NA	Dwyer Instruments	(219) 879-8000
Gauges & Measurement Devices	Pressure gauge	Dwyer Instruments	NA	Dwyer Instruments	(219) 879-8000

Table 1
Equipment Index - Off-Site ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

Location	Description	Manufacturer	Model	Vendor	Contact
Gauges & Measurement Devices	Magnahelic gauge	Dwyer Instruments	605 Series	Dwyer Instruments	(219) 879-8000
Gauges & Measurement Devices	Pitot tube	Dwyer Instruments	DS-300-6"	Dwyer Instruments	(219) 879-8000
Gauges & Measurement Devices	Pressure transducer (at blower outlet)	Rosemount	Rosemont Series 2088	Austgen Electric	(219) 924-7528
Gauges & Measurement Devices	Level transmitter (knockout tank)	Magnetrol	Eclipse Series 708-511A-310	Pinnacle Sales	(630) 416-6660
Vacuum Blower	Vacuum blower/motor	Hibon	SNH/V 815	Fliteway Technologies	(800) 236-3580
Vacuum Blower	Vacuum blower/motor	Gardner-Denver	Model 6L	Gardner-Denver	(773) 632-5000
Vacuum Blower	Inline air filter	Solberg	F75-2	Solberg Mfg	(630) 773-1363
Vacuum Blower	Replacement element for inline air filter	Stoddard	F8-110	USA Blue Book	(800) 548-1234
Knockout Tank	500 gallon SS Knockout tanks (250-gallon fluid capacity)	Fliteway Technologies Inc.	TK-V500-6F W/D	Fliteway Technologies	(800) 236-3580
Knockout Tank	Condensate pump - 1 hp	Moyno	36701	Fliteway Technologies	(800) 236-3580
Air Sparge Blower	Rotary vane pump	Becker Pumps Corp.	KDT 3.80	Fliteway Technologies	(800) 236-3580

Note: Table does not include electrical/control equipment. See Construction Completion Report.
NA - Not applicable

Table 2
Equipment Index - SBPA ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact
	SVE Stickup Well	4" dia. SS well casing	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	SVE Stickup Well	4" dia. SS well casing with 0.010" screen	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	SVE Stickup Well	4"x 3" dia. SS pipe saddle	NA	JCM 438 Tapping Sleeve	Forrer Supply Company	(800) 255-1030
	SVE Stickup Well	3" dia. SS pipe nipple	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Stickup Well	3" dia. SS NPT pipe flange	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Stickup Well	3" dia. SDR 11 HDPE pipe flange adapter with SS backup ring	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Stickup Well	Expandable test plug	NA	Monitor Well Plugs	USA Blue Book	(800) 548-1234
	SVE Stickup Well	3" dia. SDR 11 HDPE vapor conveyance piping	Chevron Phillips	DriscoPlex 4100	NA	NA
	SVE Flush Mount Well	4" dia. SS well casing	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	SVE Flush Mount Well	4" dia. SS well casing with 0.010" screen	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	SVE Flush Mount Well	6"x 3" dia. SS pipe saddle	NA	JCM 438 Tapping Sleeve	Forrer Supply Company	(800) 255-1030
	SVE Flush Mount Well	3" dia. SS pipe nipple	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Flush Mount Well	3" dia. SS NPT pipe flange	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Flush Mount Well	3" dia. SDR 11 HDPE pipe flange adapter with SS backup ring	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Flush Mount Well	Expandable test plug	NA	Monitor Well Plugs	USA Blue Book	(800) 548-1234
	SVE Flush Mount Well	18" steel protective flush mount vault	NA	NA	Forrer Supply Company	(800) 255-1030
	SVE Flush Mount Well	3" dia. SDR 11 HDPE vapor conveyance piping	Chevron Phillips	DriscoPlex 4100	NA	NA
	Dual Phase Well	6" dia. SCH 40 SS well casing	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	Dual Phase Well	6" dia. SCH 40 SS well casing with 0.010" well screen	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279

Table 2
Equipment Index - SBPA ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact
	Dual Phase Well	6"x 3" dia. SS pipe saddle	NA	JCM 438 Tapping Sleeve	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	3" dia. SS pipe nipple	NA	NA	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	3" dia. SS NPT pipe flange	NA	NA	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	3" dia. SDR 11 HDPE flange adapter with SS backup ring	NA	NA	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	Flange well cap with nylon compression fitting and eyebolt	NA	NA	Global Drilling Supplies	(800) 252-5279
	Dual Phase Well	Pneumatic Pump	Clean Environment	AP-3/BL	TCL Process Technologies	(920) 254-5204
	Dual Phase Well	1" dia. SS pitless adapter	NA	NA	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	1" dia. SS/HDPE transition fitting	NA	NA	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	3"x 1" HDPE pipe reducer	NA	NA	Forrer Supply Company	(800) 255-1030
	Dual Phase Well	3" x 3" x 3" SDR 11	Chevron Phillips	DriscoPlex 4100 Series Fittings	NA	NA
	Dual Phase Well	3" dia. HDPE groundwater conveyance pipe	Chevron Phillips	DriscoPlex 4100	NA	NA
	Dual Phase Well	3/8" dia. tubing	NA	Monitor Well Plugs	USA Blue Book	(800) 548-1234
	Dual Phase Well	1" dia. HDPE compressed air supply pipe	Chevron Phillips	DriscoPlex 4100	NA	NA
	Dual Phase Well	18" steel protective flush mount vault	NA	NA	Forrer Supply Company	(800) 255-1030
	Air Sparge Well	1" dia. SCH 40 SS well casing	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	Air Sparge Well	1" dia. SCH 40 SS well casing with 0.010" screen	U.S. Filter/ Johnson Screens	NA	Global Drilling Supplies	(800) 252-5279
	Air Sparge Well	1" x 1" SS tee	NA	NA	Forrer Supply Company	(800) 255-1030
	Air Sparge Well	1" brass ball valve	NA	Stock #16946	USA Blue Book	(800) 548-1234
	Air Sparge Well	1" dia. SS compressed air supply pipe	Chevron Phillips	DriscoPlex 4100	NA	NA

Table 2
Equipment Index - SBPA ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact
	Air Sparge Well	1" dia. SS threaded well cap	NA	NA	Forrer Supply Company	(800) 255-1030
	Air Sparge Well	12" steel protective flush mount vault	NA	NA	Forrer Supply Company	(800) 255-1030
	Piping to Building 1	3" dia. HDPE vapor conveyance pipe	Chevron Phillips	DriscoPlex 4100	NA	NA
	Piping to Building 1	1" dia. HDPE compressed air supply pipe	Chevron Phillips	DriscoPlex 4100	NA	NA
	Piping to Building 1	SS/HDPE transition fitting	NA	NA	Forrer Supply Company	(800) 255-1030
	System Building Utilities	Wall mounted ventilation fan with louvered vents	New York Blower Co.	EN122	Fliteway Technologies	(800) 236-3580
	System Building Utilities	Thermostat (rated for hazardous locations)	Columbus Electric	EPETD8D	Fliteway Technologies	(800) 236-3580
	System Building Utilities	Electrical convection heater	Dayton	FEP-3648-1RA or 3UG73	Fliteway Technologies	(800) 236-3580
	System Building Utilities	150 W light (rated for hazardous locations)	Hubbel/Killark	V Series Lighting, Fixture Type 100	Fliteway Technologies	(800) 236-3580
	System Building Pipe	3" clear flexible PVC connector pipe	NA	NA	J&L Fasteners	(219) 845-8500
	System Building Pipe	6" dia. SCH 80 PVC header pipe	NA	NA	Forrer Supply Company	(800) 255-1030
	System Building Pipe	6" dia. 304 SS pipe (inlet & outlet for knockout tank)	NA	NA	Forrer Supply Company	(800) 255-1030
	System Building Pipe	1" dia. galvanized air supply pipe (for air sparge wells)	NA	NA	Forrer Supply Company	(800) 255-1030
	System Building Pipe	2" dia. galvanized manifold pipe (for air sparge wells)	NA	NA	Forrer Supply Company	(800) 255-1030
	System Building Pipe	6" silencer	Universal Silencer	U5-6	Fliteway Technologies	(800) 236-3580
	System Building Pipe	Ambient air silencer	Universal Silencer	Lil Hummer CB-6	Fliteway Technologies	(800) 236-3580
	Valves & Fittings	6" bronze butterfly regulator valve for SVE header system	W.E. Anderson	MBVL 1206	Dwyer Instruments	(219) 879-8000
	Valves & Fittings	1" dia. ball valve (air sparge/dual phase wells)	NA	NA	USA Blue Book	(800) 548-1234
	Valves & Fittings	3" PVC knife gate valve (SVE riser pipes)	Valterra	Stock #18251	USA Blue Book	(800) 548-1234

Table 2
Equipment Index - SBPA ISVE System
American Chemical Services NPL Site,
Griffith, Indiana

ID	Location	Description	Manufacturer	Model	Vendor	Contact
	Valves & Fittings	6" dia. check valve	Spears	No. 4423-060	USA Blue Book	(800) 548-1234
	Valves & Fittings	3" dia. Ambient bypass valve	Asahi/America	Series 94	USA Blue Book	(800) 548-1234
	Valves & Fittings	Vacuum relief valve	Kunkle Valve Division	215V	Fliteway Technologies	(800) 236-3580
	Valves & Fittings	Pressure relief valve	Kunkle Valve Division	337	Fliteway Technologies	(800) 236-3580
	Gauges & Measurement Devices	Vacuum Gauges	Winters	P304V	Dwyer Instruments	(219) 879-8000
	Gauges & Measurement Devices	Temperature gauge	Dwyer Instruments	NA	Dwyer Instruments	(219) 879-8000
	Gauges & Measurement Devices	Pressure gauge	Dwyer Instruments	NA	Dwyer Instruments	(219) 879-8000
	Gauges & Measurement Devices	Magnahelic gauge	Dwyer Instruments	605 Series	Dwyer Instruments	(219) 879-8000
	Gauges & Measurement Devices	Pitot tube	Dwyer Instruments	DS-300-6"	Dwyer Instruments	(219) 879-8000
	Gauges & Measurement Devices	Pressure transducer (at blower outlet)	Rosemount	Rosemont Series 2088	Austgen Electric	(219) 924-7528
	Gauges & Measurement Devices	Level transmitter (knockout tank)	Magnetrol	Eclipse Series 708-511A-310	Pinnacle Sales	(630) 416-6660
	Vacuum Blower	Vacuum blower/motor	Hibon	SNH/V 815	Fliteway Technologies	(800) 236-3580
	Vacuum Blower	Inline air filter	Solberg	F75-2	Solberg Mfg	(630) 773-1363
	Vacuum Blower	Replacement element for inline air filter	Solberg	F8-110	Solberg Mfg	(630) 773-1363
	Knockout Tank	500 gallon SS Knockout tank (300-gallon fluid capacity)	Fliteway Technologies Inc.	TK-V500-6F W/D	Fliteway Technologies Inc.	(800) 236-3580
	Knockout Tank	Condensate pump - 1 hp	Moyno	36701	Fliteway Technologies Inc.	(800) 236-3580
	Air Sparge Blower	Rotary vane pump	Becker Pumps Corp.	KDT 3.80	Fliteway Technologies Inc.	(800) 236-3580

Note: Table does not include electrical/control equipment. See Construction Completion Report.
NA - Not applicable

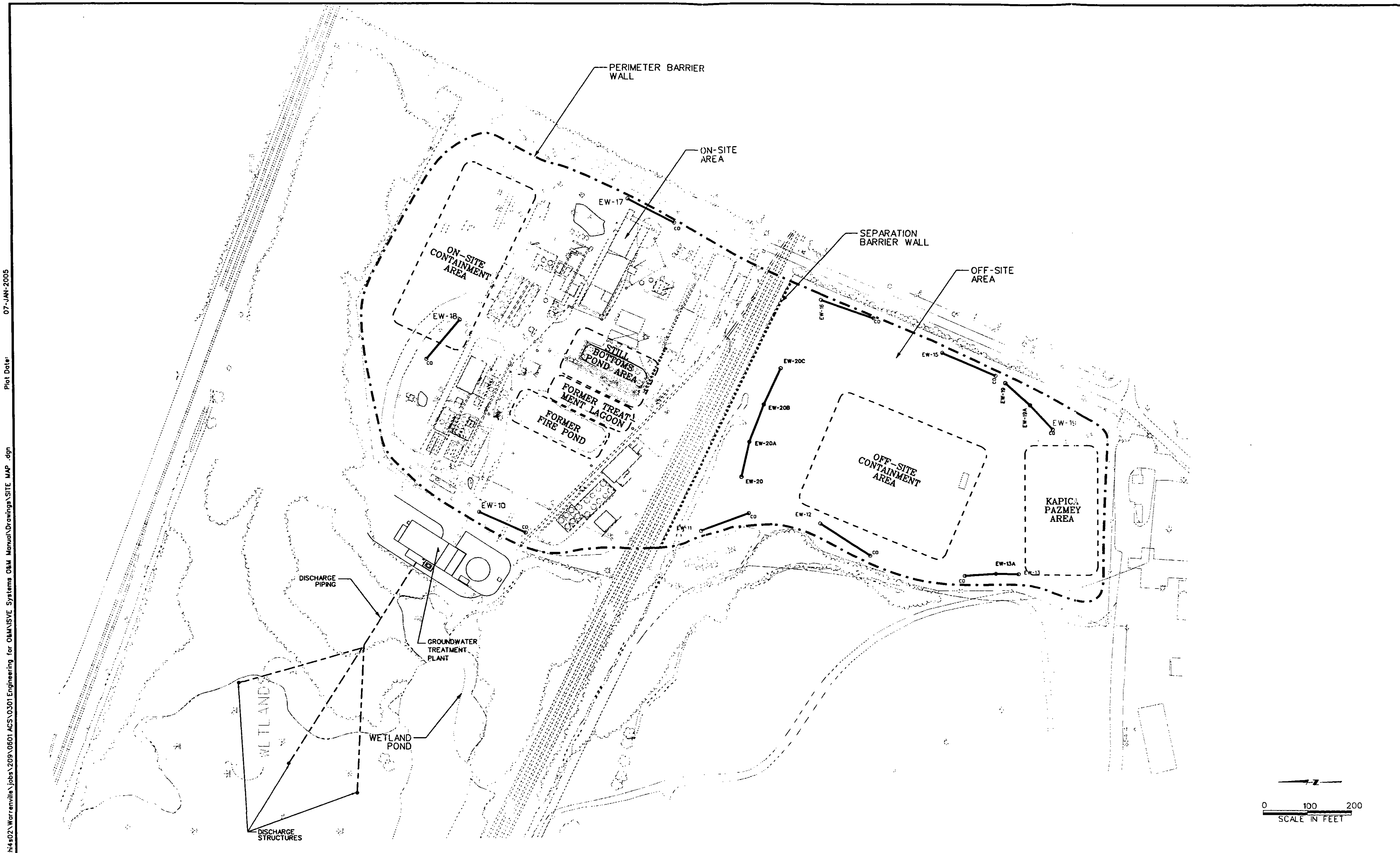
MBM/JDP/CAD/jmf
J:\209\0601 ACS\0301 Engineering for O\ISVE Systems O Manual\Parts List_rev2.xls\Table 2 - SBPA System

Table 3
Recommended Spare Parts List
American Chemical Services NPL Site,
Griffith, Indiana

Equipment	Spare Part/Item	Quantity
Thermal Oxidizer/Scrubber Unit (ThermOx 1)	pH sensor	1
	Conductivity sensor	1
	Flow meters, water (rotometer-type)	1
	Temperature sensor, water	1
	Pressure gauges	1
	Spray nozzles	1
	Y-strainer	1
Thermal Oxidizer/Scrubber Unit (ThermOx 2)	pH sensor	1
	Conductivity sensor	1
	Flow meters, water (rotometer-type)	1
	Thermocouple, 12" dual	1
	Thermocouple, 48" triple	1
	Temperature sensor, water	1
	Pressure gauges	1
	Spray nozzles	1
	Y-strainer	1
ISVE Systems	Air filter	2
	Motor belt	2
	Magnehelic gauges	1
	Motor oil	1

FIGURES

File: \\Uschi4s02\Warrenville\jobs\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\SITE MAP.dgn Plot Date: 07-JAN-2005



REV	DATE	BY	DESCRIPTION

SCALE: AS SHOWN

DESIGNED CAD
DRAWN MM
CHECKED RAA

SUBMITTED BY
ROBERT A. ADAMS (PROJECT MANAGER) LICENSE NO. DATE
PETER J. VAGT (COMPANY OFFICER) LICENSE NO. DATE

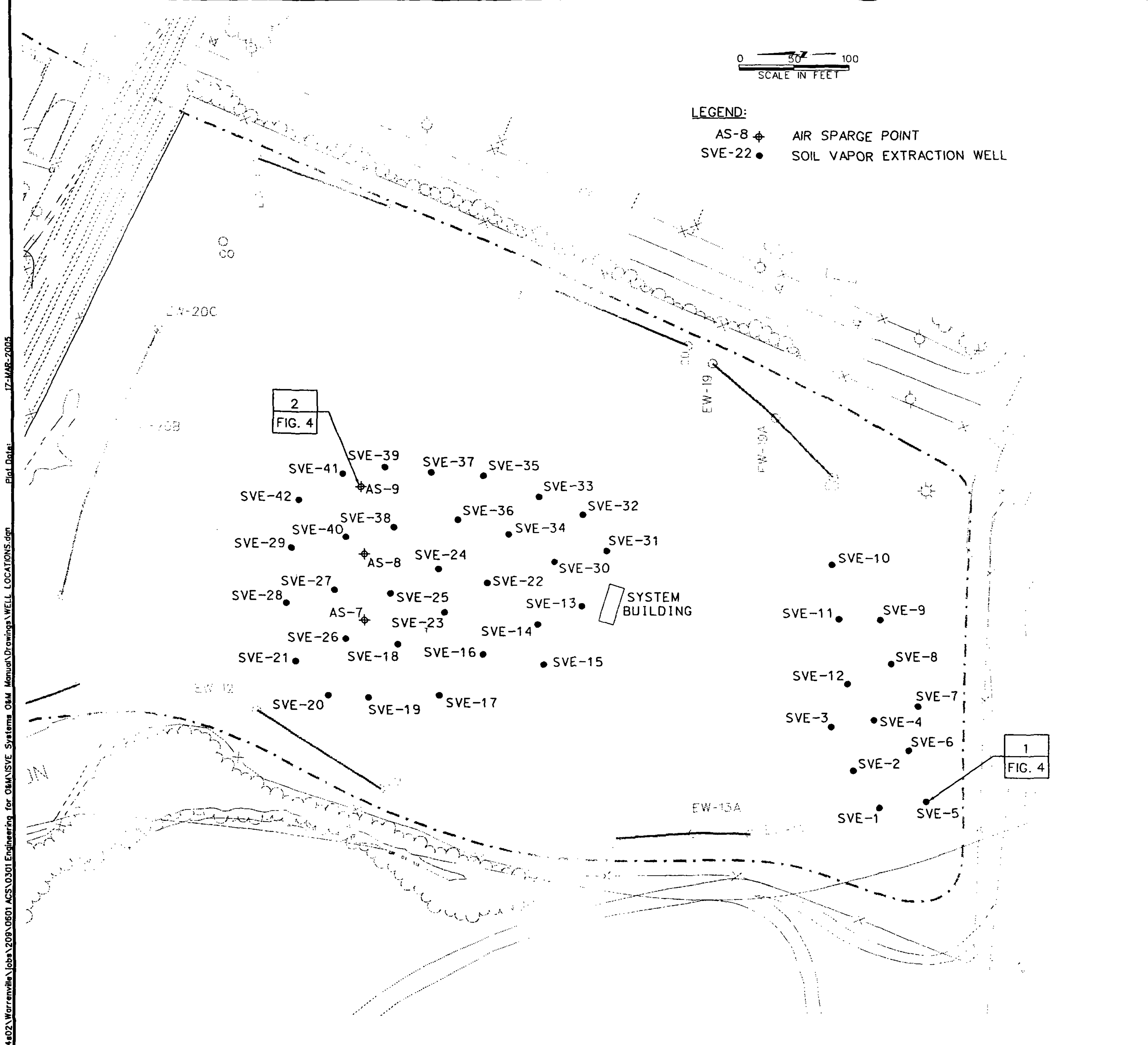
MWH

ACS RD/RA GROUP
AMERICAN CHEMICAL SERVICE SUPERFUND SITE
GRIFFITH, INDIANA

ISVE SYSTEMS O&M MANUAL

SITE LAYOUT MAP

FIGURE 1



OFF-SITE ISVE WELL AND SPARGE POINT CONSTRUCTION DETAILS

Well ID	Location Northing	Easting	Top of Casing Elevation (ft. amsl)	Total Depth of Well (ft.)	Length of Screen (ft.)	Bottom of Screen Elevation (ft. amsl)	Ground Surface Elevation (ft. amsl)
SVE-1	5757.2	5065.3	654.3	25.4	15	628.9	651.1
SVE-2	5781.2	5099.7	655.2	25.4	15	629.8	652.1
SVE-3	5800.5	5141.4	655.6	25.4	15	630.2	652.7
SVE-4	5762.0	5148.0	656.2	25.4	15	630.8	652.9
SVE-5	5713.5	5070.9	654.6	25.4	15	629.2	651.4
SVE-6	5729.6	5118.9	656.2	25.4	15	630.8	652.9
SVE-7	5720.9	5160.2	657.0	25.4	15	631.6	653.5
SVE-8	5744.8	5200.1	656.9	25.4	15	631.5	653.6
SVE-9	5754.9	5241.7	656.8	30.4	15	626.4	654.2
SVE-10	5798.4	5293.7	656.4	30.4	15	626.0	654.1
SVE-11	5792.2	5242.3	655.3	30.4	15	624.9	653.0
SVE-12	5785.2	5181.6	655.7	25.4	15	630.3	652.6
SVE-13	6028.8	5254.8	654.7	25.4	10	629.3	651.6
SVE-14	6070.3	5237.7	654.3	25.4	10	628.9	651.4
SVE-15	6065.2	5200.6	653.2	25.4	15	627.8	650.0
SVE-16	6120.3	5209.7	652.6	25.4	15	627.2	649.9
SVE-17	6162.6	5172.8	652.0	25.4	15	626.6	648.4
SVE-18	6196.9	5219.6	653.1	25.4	10	627.7	649.7
SVE-19	6225.3	5170.8	651.8	25.4	15	626.4	648.0
SVE-20	6262.4	5172.7	650.3	25.4	15	624.9	647.1
SVE-21	6292.1	5204.4	648.7	25.4	15	623.3	645.8
SVE-22	6116.3	5277.8	653.4	25.4	10	628.0	650.2
SVE-23	6155.7	5250.5	653.8	25.4	10	628.4	650.7
SVE-24	6159.7	5291.7	653.0	25.4	10	627.6	649.8
SVE-25	6204.1	5268.1	653.1	25.4	15	627.7	650.0
SVE-26	6244.7	5225.1	652.3	25.4	15	626.9	650.1
SVE-27	6255.6	5272.2	652.6	25.4	10	627.2	649.2
SVE-28	6300.3	5258.4	650.5	25.4	15	625.1	646.8
SVE-29	6295.2	5311.1	651.2	25.4	15	625.8	647.7
SVE-30	6053.6	5297.1	653.3	25.4	10	627.9	649.8
SVE-31	6004.8	5307.4	652.9	25.4	15	627.5	649.5
SVE-32	6026.1	5341.3	651.7	25.4	10	626.3	648.4
SVE-33	6068.0	5358.7	650.4	25.4	10	625.0	647.0
SVE-34	6095.7	5323.8	652.1	25.4	10	626.7	648.9
SVE-35	6119.4	5378.3	649.5	25.4	10	624.1	645.8
SVE-36	6142.6	5336.9	651.8	25.4	10	626.4	648.9
SVE-37	6166.8	5381.0	651.5	25.4	10	626.1	647.1
SVE-38	6199.7	5330.2	653.5	25.4	10	628.1	650.7
SVE-39	6208.1	5387.1	651.9	25.4	15	626.5	648.3
SVE-40	6244.6	5321.2	652.5	20.4	10	632.1	649.1
SVE-41	6247.3	5380.0	652.9	25.4	15	627.5	648.7
SVE-42	6288.2	5356.0	651.9	25.4	15	626.5	648.5
AS-7	6228.4	5243.1	652.2	32.1	2.2	620.1	649.7
AS-8	6229.0	5305.1	651.8	32.1	2.2	619.7	649.5
AS-9	6230.1	5367.2	651.2	32.1	2.2	619.1	648.5

Notes:
1 Measured from Top of Casing.
SVE-1 through SVE-12 are located in the K-P Area.
SVE-13 through SVE-42 and AS-7 through AS-9 are located in the OFCA.
NA = Not available
ft = feet
ft amsl = feet above mean sea level

REV	DATE	BY	DESCRIPTION	SCALE		SUBMITTED BY		
				AS SHOWN	DESIGNED CAD	ROBERT A. ADAMS (PROJECT MANAGER)	LICENSE NO.	DATE
					DRAWN MM	PETER J. VAGT (COMPANY OFFICER)	LICENSE NO.	DATE
					CHECKED RAA			

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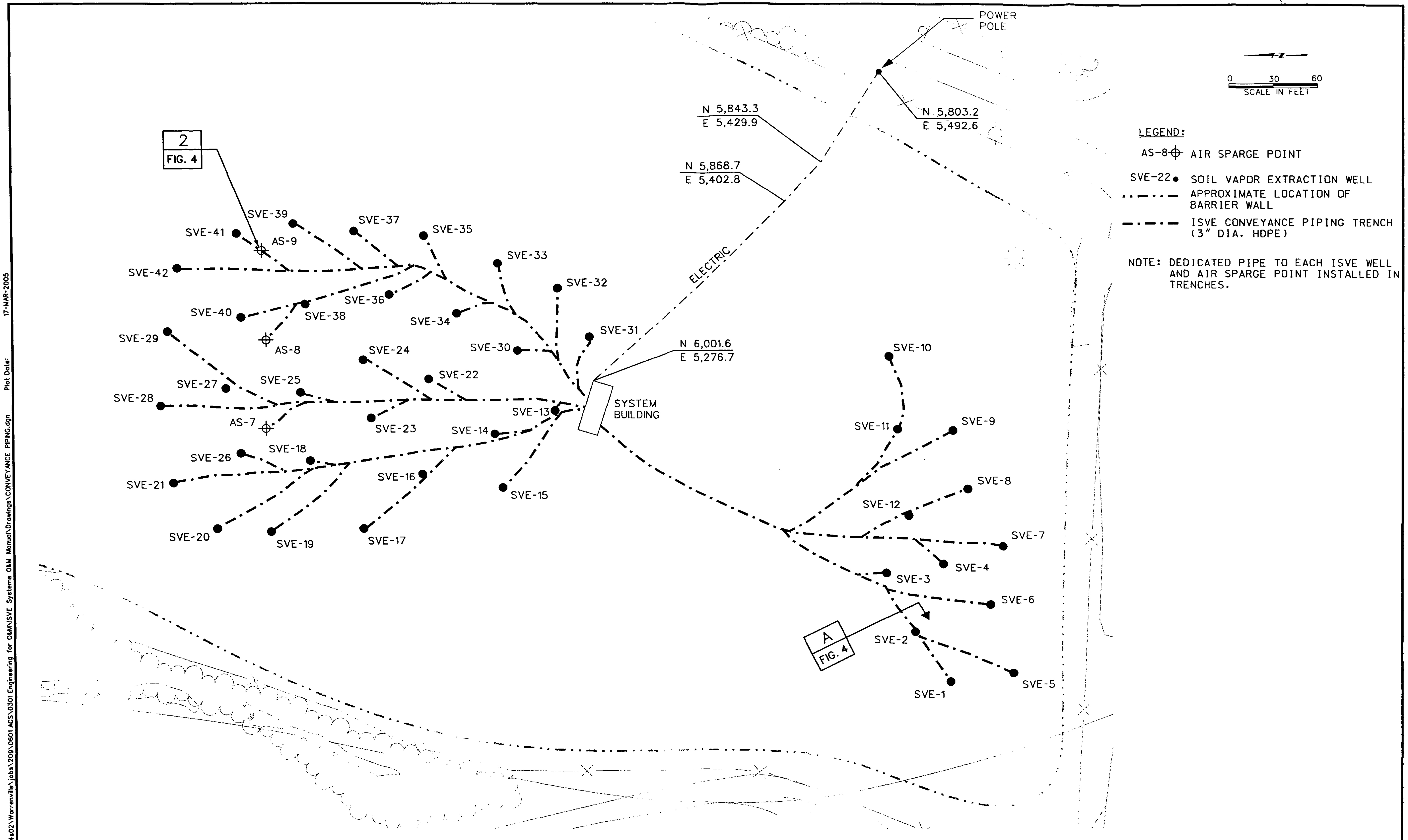
ACS RD/RA GROUP
AMERICAN CHEMICAL SERVICE SUPERFUND SITE
GRIFFITH, INDIANA

ISVE SYSTEMS O&M MANUAL
OFF-SITE AREA ISVE SYSTEM
ISVE WELL AND AS POINT LOCATIONS

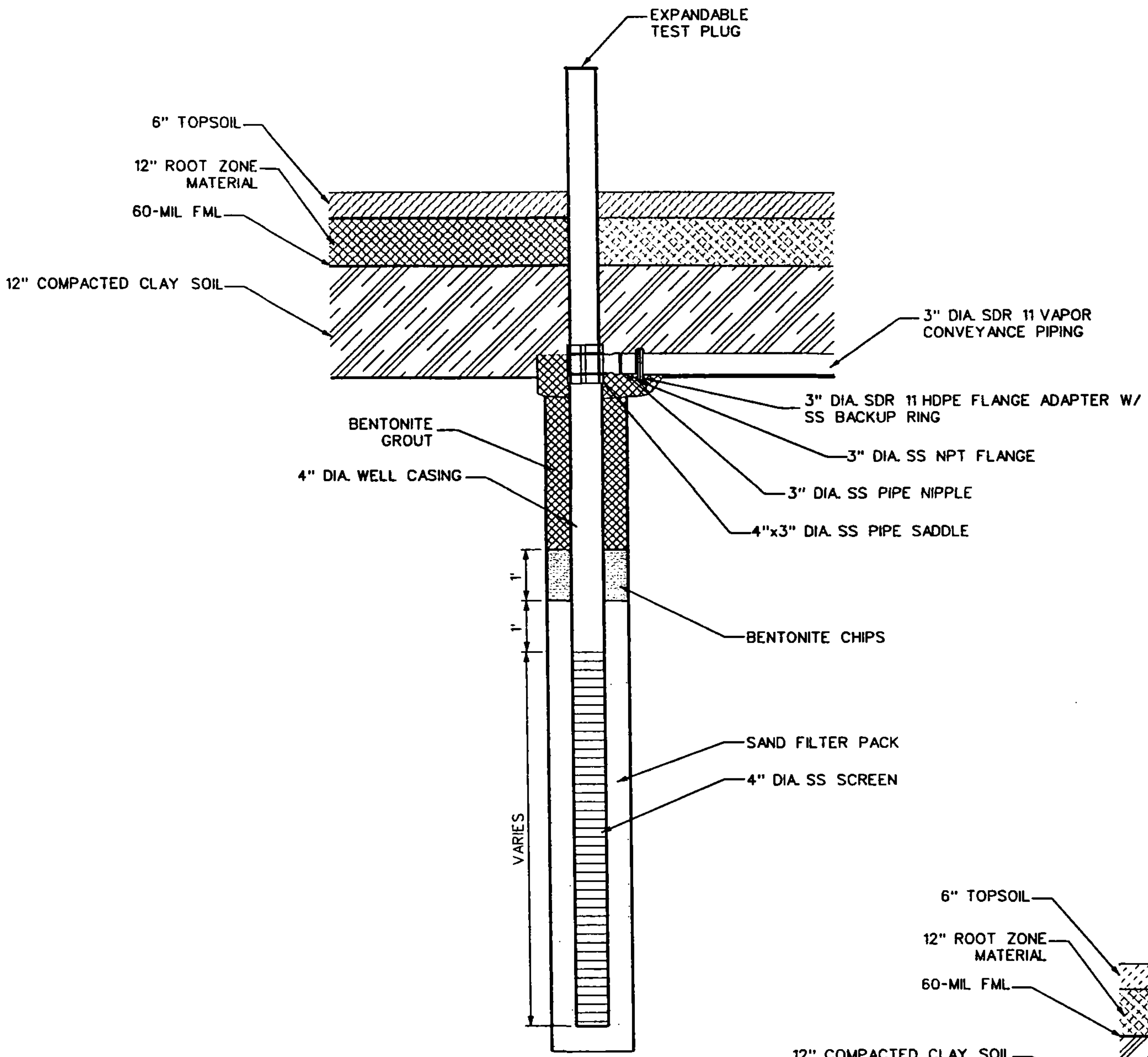
FIGURE 2

File: \\Uschi4s02\Warrenville\Jobs\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\WELL LOCATIONS.dgn Plot Date: 17-MAR-2005



File: \\Uschi4s02\Warrenville\jobs\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\CONVEYANCE PIPING.dgn Plot Date: 17-MAR-2005

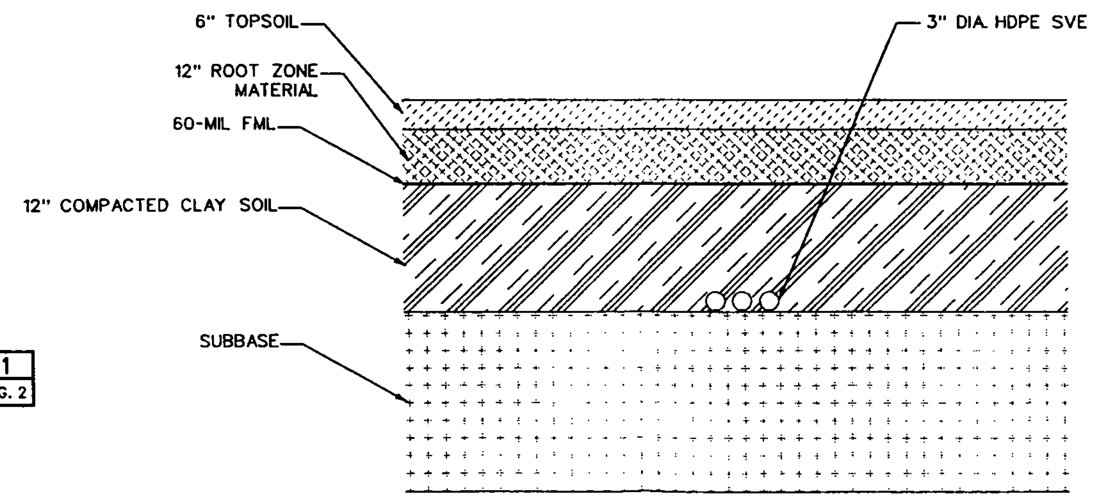
REV	DATE	BY	DESCRIPTION	SCALE		SUBMITTED BY			
				AS SHOWN	DESIGNED CAD DRAWN MM CHECKED RAA	ROBERT A. ADAMS (PROJECT MANAGER) LICENSE NO. DATE PETER J. VAGT (COMPANY OFFICER) LICENSE NO. DATE	MWH	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	ISVE SYSTEMS O&M MANUAL OFF-SITE AREA ISVE SYSTEM CONVEYANCE PIPING LAYOUT FIGURE 3



NOTE: TOTAL DEPTH AND SCREEN LENGTH VARIES.
SEE FIGURE 2 FOR WELL SCHEDULE.

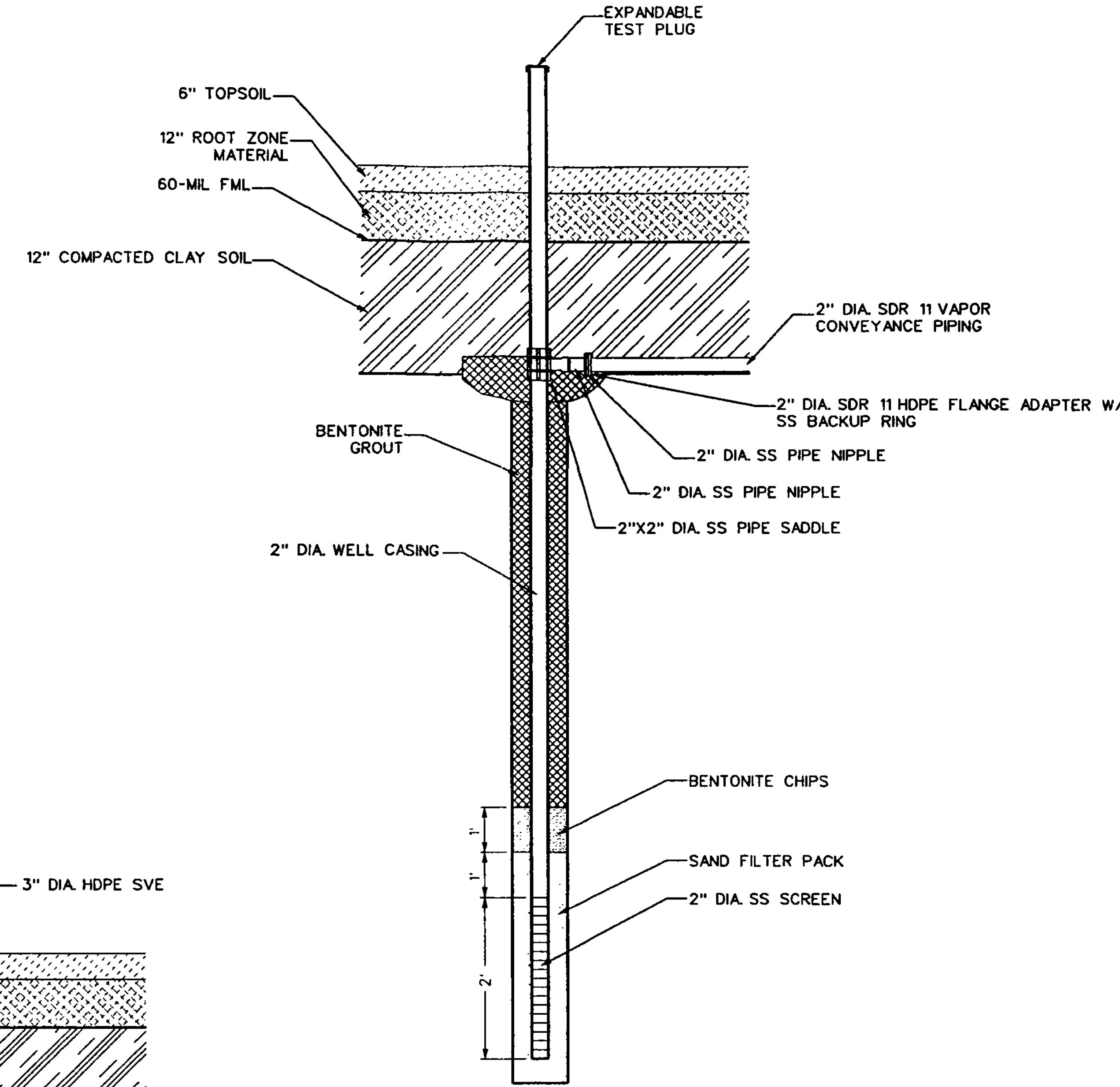
SOIL VAPOR EXTRACTION WELL (OFF-SITE AREA) FINAL CONSTRUCTION — 1 / FIG. 2

NOT TO SCALE



TYPICAL PIPING RUN (OFF-SITE AREA) — A / FIG. 3

NOT TO SCALE



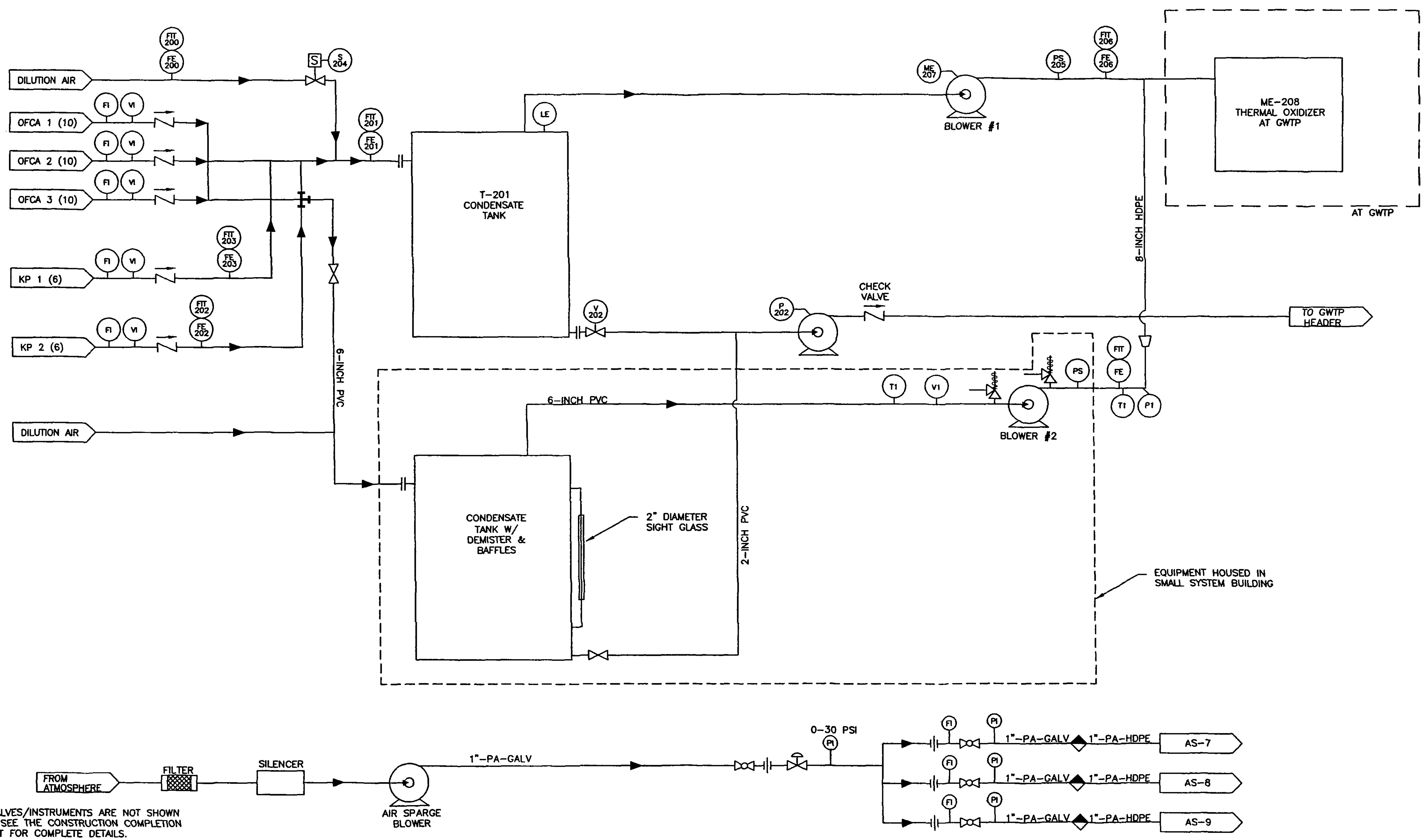
NOTE: TOTAL DEPTH OF AIR SPARGE POINTS VARIES.
SEE FIGURE 2 FOR WELL SCHEDULE.

AIR SPARGE POINT (OFF-SITE AREA) FINAL CONSTRUCTION — 2 / FIG. 2

NOT TO SCALE

REV	DATE	BY	DESCRIPTION	SCALE		SUBMITTED BY					
				AS SHOWN	DESIGNED CAD	ROBERT A. ADAMS (PROJECT MANAGER)	LICENSE NO.	DATE	MWH	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	ISVE SYSTEMS O&M MANUAL OFF-SITE AREA ISVE SYSTEM DETAILS	FIGURE 4
					DRAWN MM							
					CHECKED RAA	PETER J. VAGT (COMPANY OFFICER)	LICENSE NO.	DATE				

File: \\Uschi4s02\Warrenville\jobs\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\DETAILS.dgn Plot Date: 17-MAR-2005



NOTES:

1. ALL VALVES/INSTRUMENTS ARE NOT SHOWN HERE. SEE THE CONSTRUCTION COMPLETION REPORT FOR COMPLETE DETAILS.
2. ALL EQUIPMENT INSTALLED IN MAIN BUILDING, UNLESS OTHERWISE NOTE.

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY						
				N.T.S.	0 1/2 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED CAD DRAWN MM CHECKED RAA	ROB A. ADAMS (PROJECT MANAGER) PETER J. VAGT (COMPANY OFFICER)	LICENSE NO. LICENSE NO.	DATE DATE	MWH	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	ISVE SYSTEMS O&M MANUAL OFF-SITE ISVE SYSTEM PROCESS FLOW DIAGRAM	FIGURE 5

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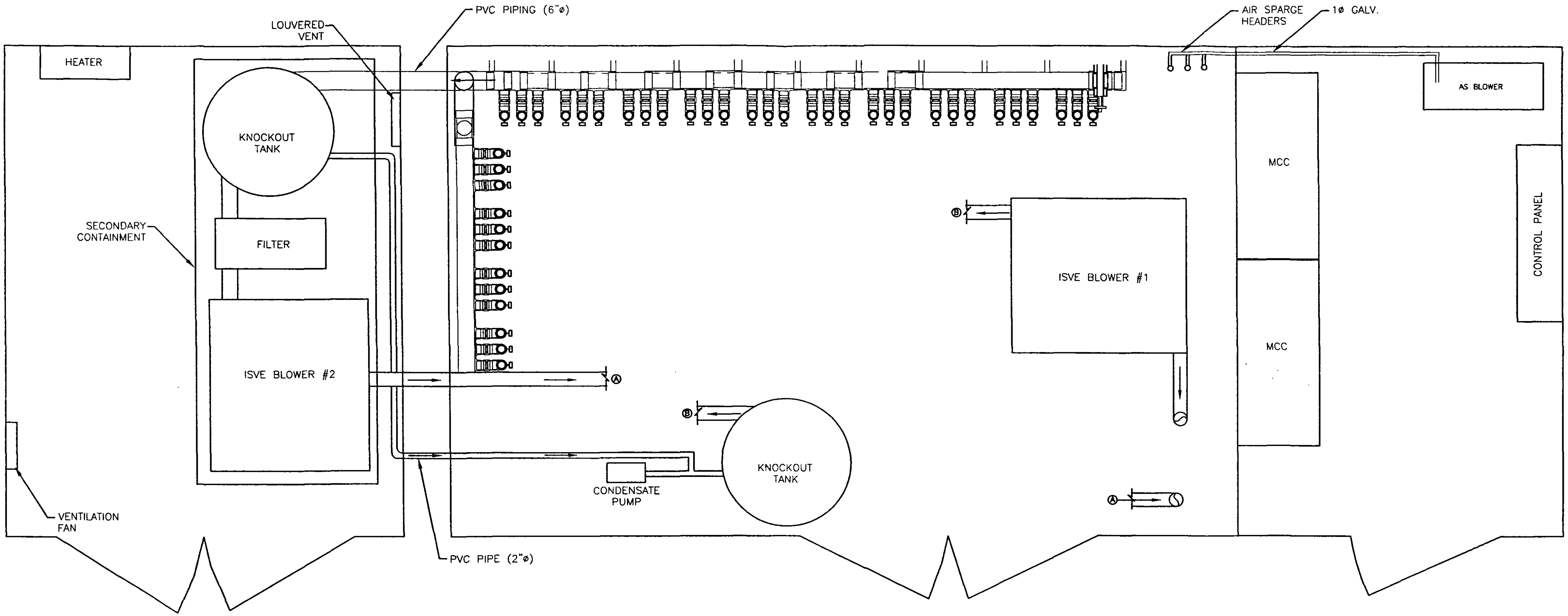


NOTE:

1. CONCRETE FOUNDATION PAD FOR THE LARGER BUILDING PROVIDES SECONDARY CONTAINMENT FOR THAT BUILDING.

REV	DATE	BY	DESCRIPTION

SCALE: N.T.S.

WARNING: 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED CAD
DRAWN MM
CHECKED RAA

SUBMITTED BY
ROB A. ADAMS (PROJECT MANAGER) LICENSE NO. DATE
PETER J. VAGT (COMPANY OFFICER) LICENSE NO. DATE

MWH

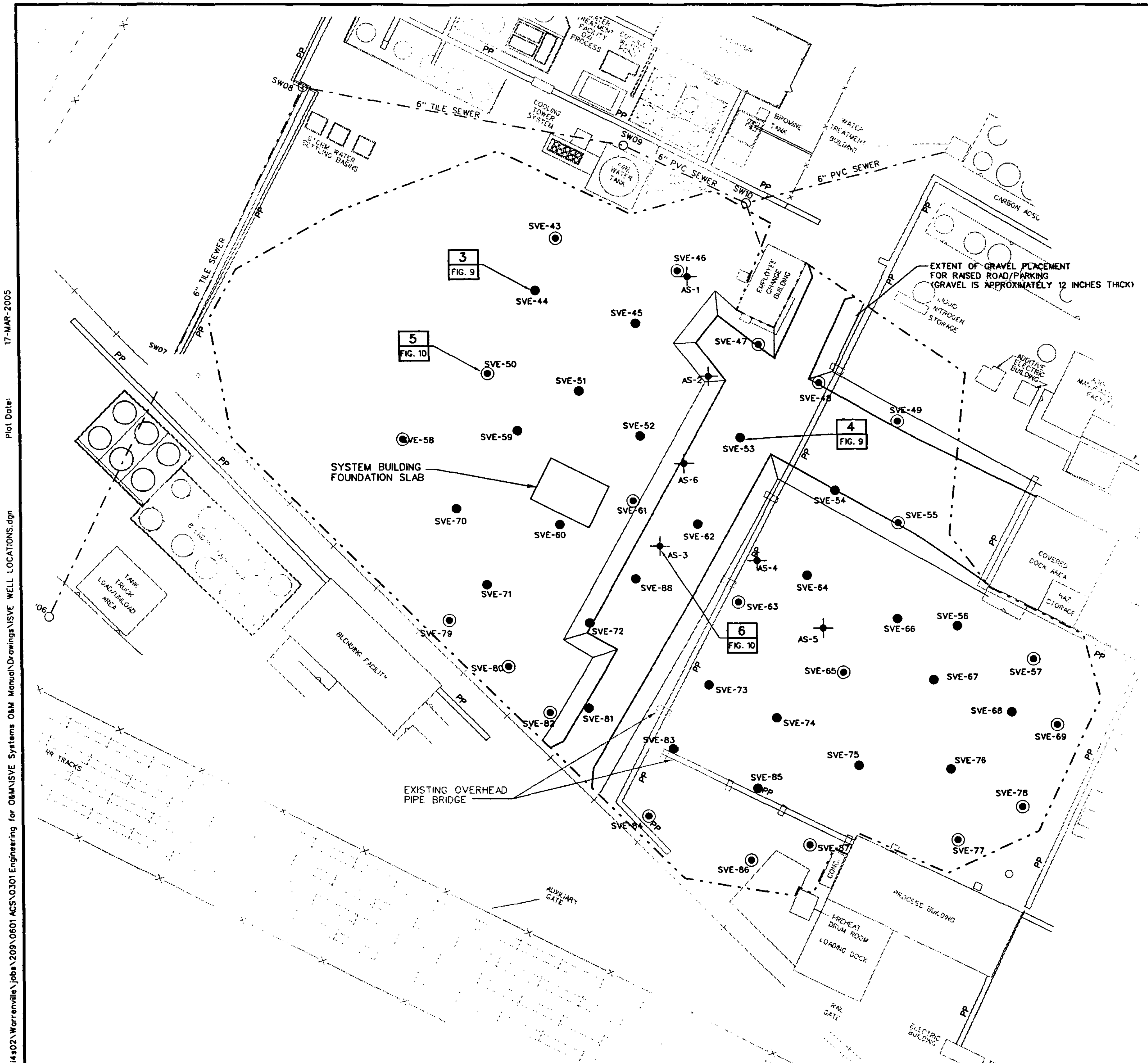
ACS RD/RA GROUP
AMERICAN CHEMICAL SERVICE SUPERFUND SITE
GRIFFITH, INDIANA

ISVE SYSTEMS O&M MANUAL

OFF-SITE AREA ISVE SYSTEM
BUILDING LAYOUT

FIGURE 6

J:\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\Building Layout.dwg Mar 17, 2005 – 9:25am



LEGEND:

- SVE-54 ● ISVE WELL LOCATION
- SVE-55 ◉ DUAL PHASE WELL LOCATION
- AS-1 ✛ AIR SPARGE POINT
- — · · — EXTENT OF COVER SYSTEM

N

0 30 60
SCALE IN FEET

Well ID	Location		Description	Head Detail	Well Diameter	Top of Casing Elevation	Total Depth of Well (Measured from Top of Casing)	Screen Length	Bottom of Screen Elevation
	Northing	Easting			(in.)	(ft. amsl)	(ft.)	(ft)	(ft. amsl)
SVE- 43	7015.0	5403.7	Dual-Phase	flush	6	641.36	20.58	15	620.8
SVE- 44	6986.1	5392.1	ISVE only	stick-up	4	646.39	15.00	5	631.4
SVE- 45	6968.0	5447.1	ISVE only	stick-up	4	645.91	25.00	15	620.9
SVE- 46	6997.1	5470.5	Dual-Phase	flush	6	641.42	20.30	15	621.1
SVE- 47	6956.3	5514.9	Dual-Phase	flush	6	641.49	20.20	15	621.3
SVE- 48	6935.1	5547.7	Dual-Phase	flush	6	641.82	21.15	15	620.7
SVE- 49	6913.8	5591.0	Dual-Phase	flush	6	641.32	21.32	15	620.0
SVE- 50	6940.4	5365.7	Dual-Phase	flush	6	643.22	21.72	15	621.5
SVE- 51	6930.6	5415.6	ISVE only	stick-up	4	647.09	15.00	5	632.1
SVE- 52	6905.5	5449.1	ISVE only	stick-up	4	647.18	15.00	5	632.2
SVE- 53	6904.6	5504.3	ISVE only	flush	4	642.93	11.31	5	631.6
SVE- 54	6875.4	5556.2	ISVE only	flush	4	642.41	11.31	5	631.1
SVE- 55	6857.3	5590.8	Dual-Phase	flush	6	641.62	21.52	15	620.1
SVE- 56	6800.0	5622.8	ISVE only	stick-up	4	645.40	15.00	5	630.4
SVE- 57	6781.5	5664.6	Dual-Phase	flush	6	640.66	20.99	15	619.7
SVE- 58	6903.7	5318.7	Dual-Phase	flush	6	642.50	20.71	15	621.8
SVE- 59	6908.6	5381.9	ISVE only	stick-up	4	647.53	15.00	5	632.5
SVE- 60	6856.4	5404.5	ISVE only	stick-up	4	647.23	15.00	5	632.2
SVE- 61	6869.4	5445.0	Dual-Phase	flush	6	642.83	22.37	15	620.5
SVE- 62	6856.5	5480.3	ISVE only	flush	4	643.26	11.66	5	631.6
SVE- 63	6813.2	5502.5	Dual-Phase	flush	6	642.40	22.60	15	619.8
SVE- 64	6828.1	5540.5	ISVE only	stick-up	4	646.60	15.00	5	631.6
SVE- 65	6774.1	5560.0	Dual-Phase	flush	6	642.45	22.76	15	619.7
SVE- 66	6804.0	5590.1	ISVE only	stick-up	4	645.66	15.00	5	630.7
SVE- 67	6769.8	5609.7	ISVE only	stick-up	4	646.25	15.00	5	631.3
SVE- 68	6752.0	5652.5	ISVE only	stick-up	4	645.70	15.00	5	630.7
SVE- 69	6745.0	5677.4	Dual-Phase	flush	6	640.38	20.65	15	619.7
SVE- 70	6865.1	5348.1	ISVE only	stick-up	4	646.77	15.00	5	631.8
SVE- 71	6823.0	5364.5	ISVE only	stick-up	4	645.80	15.00	5	630.8
SVE- 72	6801.7	5420.4	ISVE only	flush	4	642.30	10.78	5	631.5
SVE- 73	6767.2	5485.7	ISVE only	stick-up	4	646.19	15.00	5	631.2
SVE- 74	6748.7	5523.2	ISVE only	stick-up	4	646.23	15.00	5	631.2
SVE- 75	6722.4	5568.1	ISVE only	stick-up	4	645.50	15.00	5	630.5
SVE- 76	6720.1	5619.0	ISVE only	stick-up	4	645.92	15.00	5	630.9
SVE- 77	6681.1	5622.2	Dual-Phase	flush	6	639.64	20.54	15	619.1
SVE- 78	6699.3	5658.1	Dual-Phase	flush	6	640.45	20.04	15	620.4
SVE- 79	6803.2	5343.5	Dual-Phase	flush	6	639.55	20.51	15	619.0
SVE- 80	6777.6	5375.7	Dual-Phase	flush	6	639.94	20.71	15	619.2
SVE- 81	6754.4	5419.4	ISVE only	flush	4	640.65	11.02	5	629.6
SVE- 82	6751.9	5398.2	Dual-Phase	flush	6	639.09	20.57	15	618.5
SVE- 83	6731.6	5465.9	ISVE only	stick-up	4	645.52	15.00	5	630.5
SVE- 84	6694.4	5452.0	Dual-Phase	flush	6	638.76	20.88	15	617.9
SVE- 85	6709.7	5512.4	ISVE only	stick-up	4	645.54	15.00	5	630.5
SVE- 86	6670.0	5508.4	Dual-Phase	flush	6	639.36	20.65	15	618.7
SVE- 87	6678.3	5540.6	Dual-Phase	flush	6	639.62	20.89	15	618.7
SVE- 88	6826.1	5446.1	ISVE only	flush	4	643.03	11.17	5	631.9
AS- 1	6993.8	5475.7	Air-Sparge Well	flush	1	641.04	20.00	2	621.0
AS- 2	6938.6	5486.9	Air-Sparge Well	flush	1	641.91	20.00	2	621.9
AS- 3	6844.4	5459.5	Air-Sparge Well	flush	1	642.82	20.00	2	622.8
AS- 4	6836.3	5513.1	Air-Sparge Well	flush	1	641.75	20.00	2	621.8
AS- 5	6798.7	5549.1	Air-Sparge Well	flush	1	641.93	20.00	2	621.9
AS- 6	6890.2	5473.1	Air-Sparge Well	flush	1	642.50	20.00	2	622.5

Notes:
NA = Not available
in = inches
ft = feet
ft amsl = feet above mean sea level

File: \\Uschi4s02\Warrenville\Jobs\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\ISVE WELL LOCATIONS.dgn Plot Date: 17-MAR-2005

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY		
				AS SHOWN	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED CAD DRAWN MM CHECKED RAA	ROBERT A. ADAMS (PROJECT MANAGER) PETER VAGT (COMPANY OFFICER)	LICENSE NO. LICENSE NO.	DATE DATE

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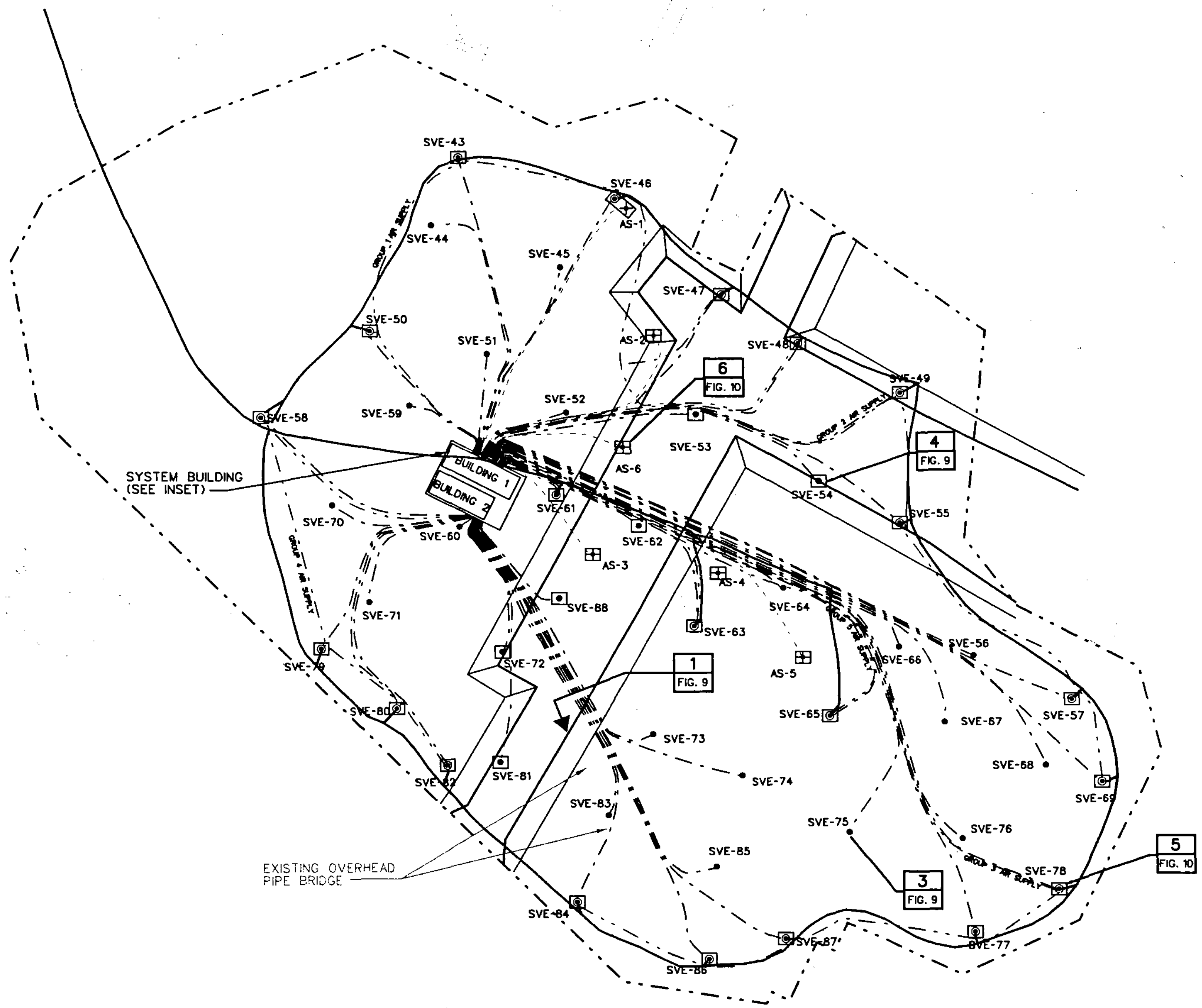
ACS RD/RA GROUP
AMERICAN CHEMICAL SERVICE SUPERFUND SITE
GRIFFITH, INDIANA

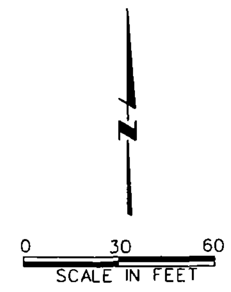
STILL BOTTOMS POND AREA ISVE SYSTEM CCR

ISVE WELL LOCATIONS
(INCLUDING DUAL PHASE EXTRACTION WELLS AND AIR SPARGE WELLS)

FIGURE
7

Plot Date: 17-MAR-2005



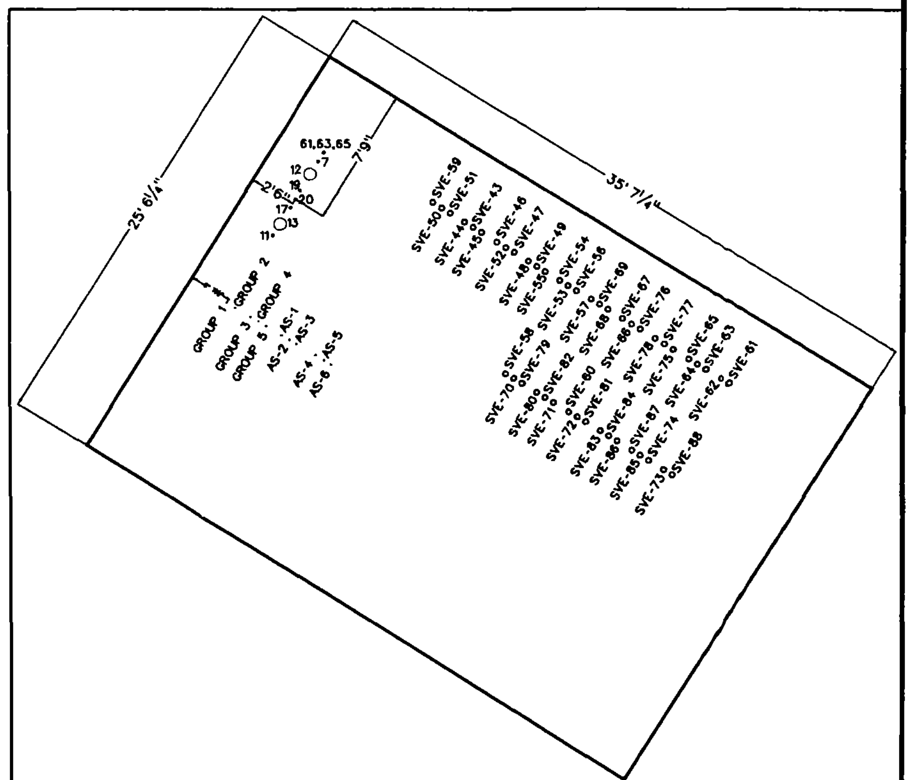


LEGEND:

SVE-54 •	ISVE WELL LOCATION
SVE-55 ⊡	DUAL PHASE WELL LOCATION
AS-1 +	AIR SPARGE POINT
□	FLUSH-MOUNT COVER
— · · —	DPE PUMP COMPRESSED AIR LINE (1" HDPE)
- - - - -	AIR SPARGE PIPING (1" HDPE)
— · — ·	ISVE CONVEYANCE PIPING (3" HDPE)
———	GROUNDWATER CONVEYANCE PIPE
——	GROUNDWATER CONVEYANCE PIPE STUB

NOTES:

1. PIPING LOCATIONS ARE APPROXIMATE.
2. CONCRETE ENCASEMENTS WERE PLACED AROUND ALL PIPING INSTALLED ABOVE THE CLAY LAYER THAT WAS LOCATED IN TRAFFIC AREAS.

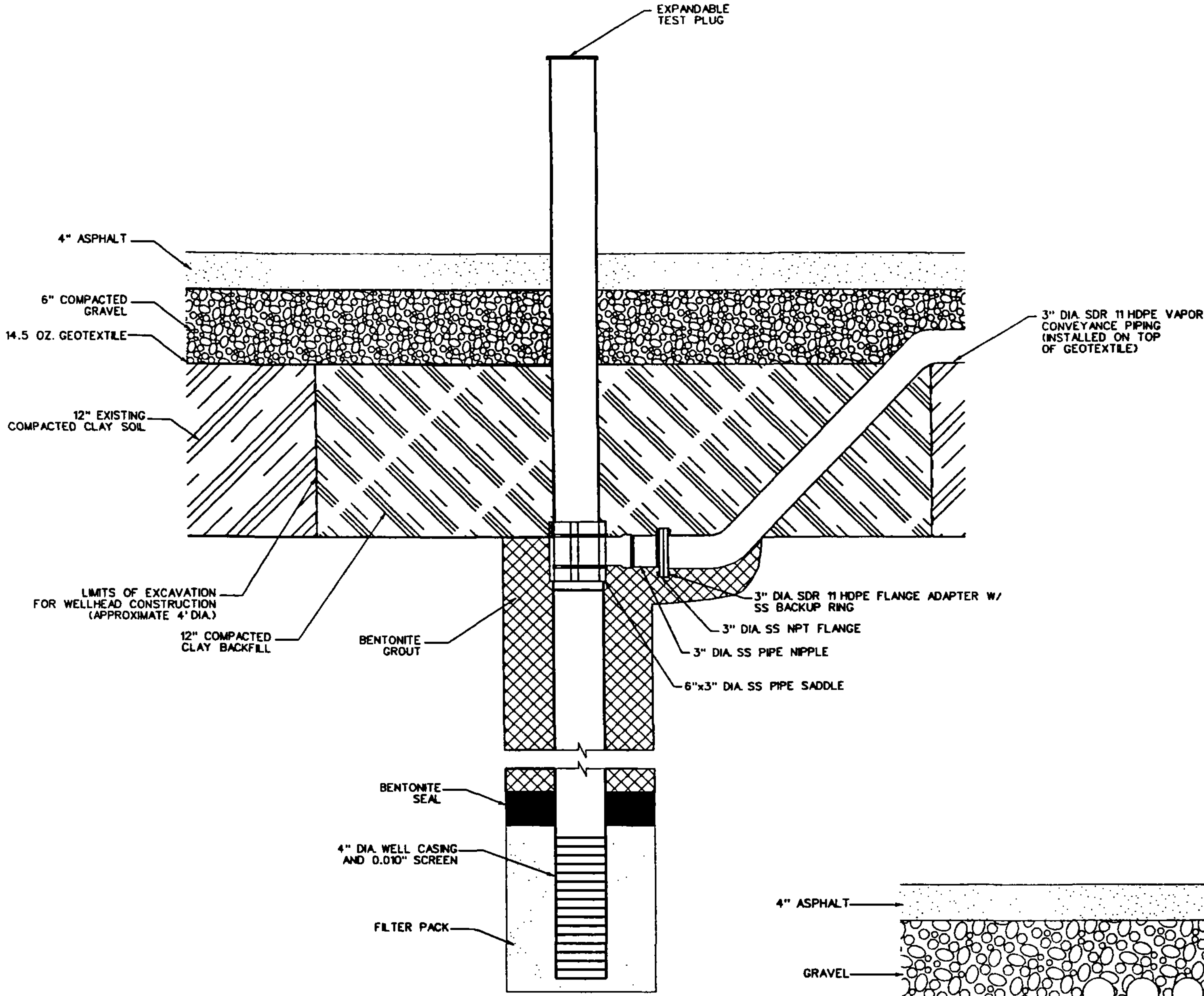


SYSTEM BUILDING INSET AND PIPING LAYOUT
N.T.S.

NOTE: PIPES DESIGNATED AS "GROUP-" AND "AS-" ARE RUN OUTSIDE OF BUILDING AND ARE NOT PART OF THE ISVE HEADER SYSTEM.

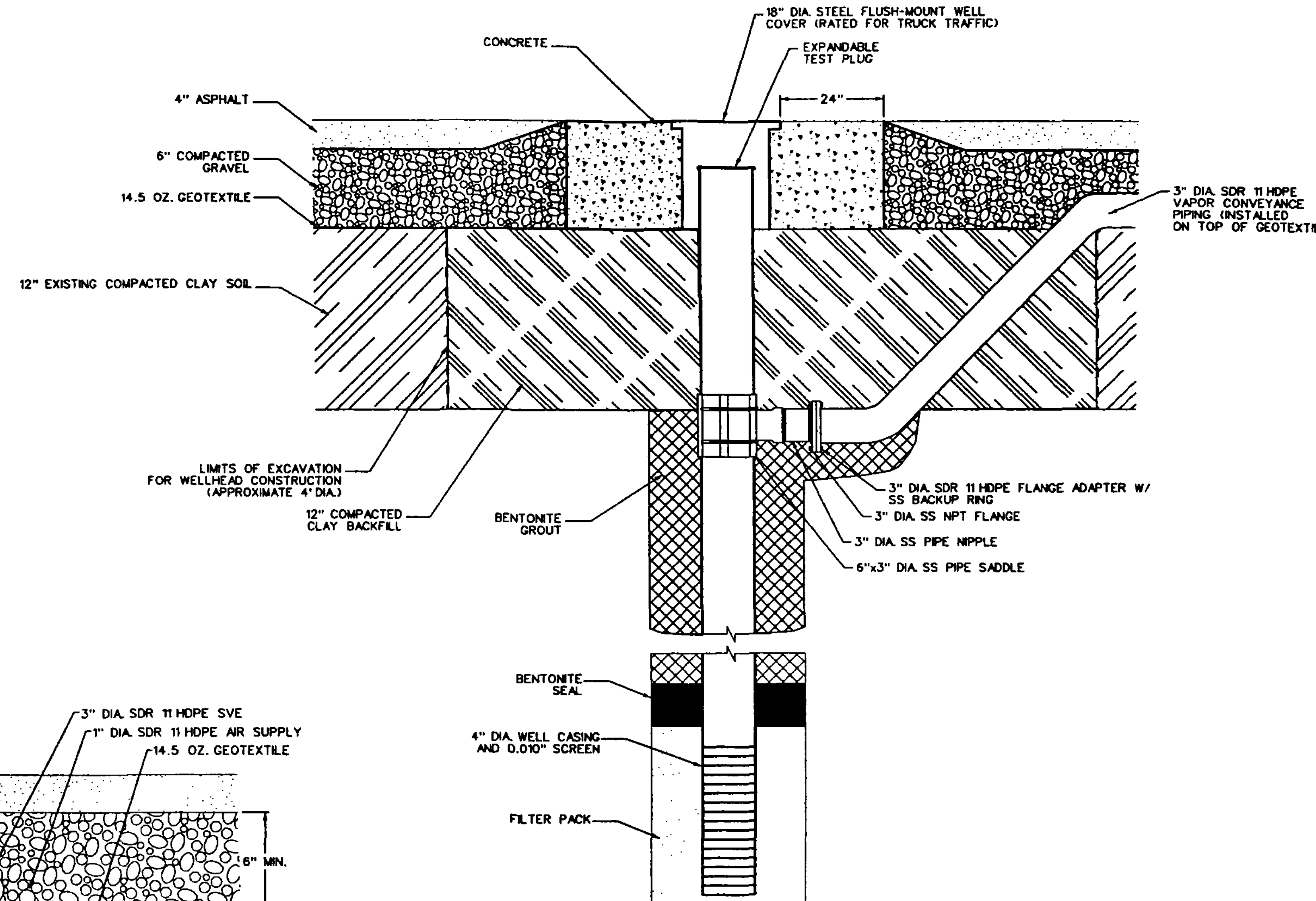
File:

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY				
				AS SHOWN	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED CAD DRAWN MM CHECKED RAA	ROBERT A. ADAMS (PROJECT MANAGER) LICENSE NO. DATE PETER J. VAGT (COMPANY OFFICER) LICENSE NO. DATE	MWH	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	ISVE SYSTEMS O&M MANUAL SBPA ISVE SYSTEM ISVE CONVEYANCE PIPING LAYOUT	FIGURE 8



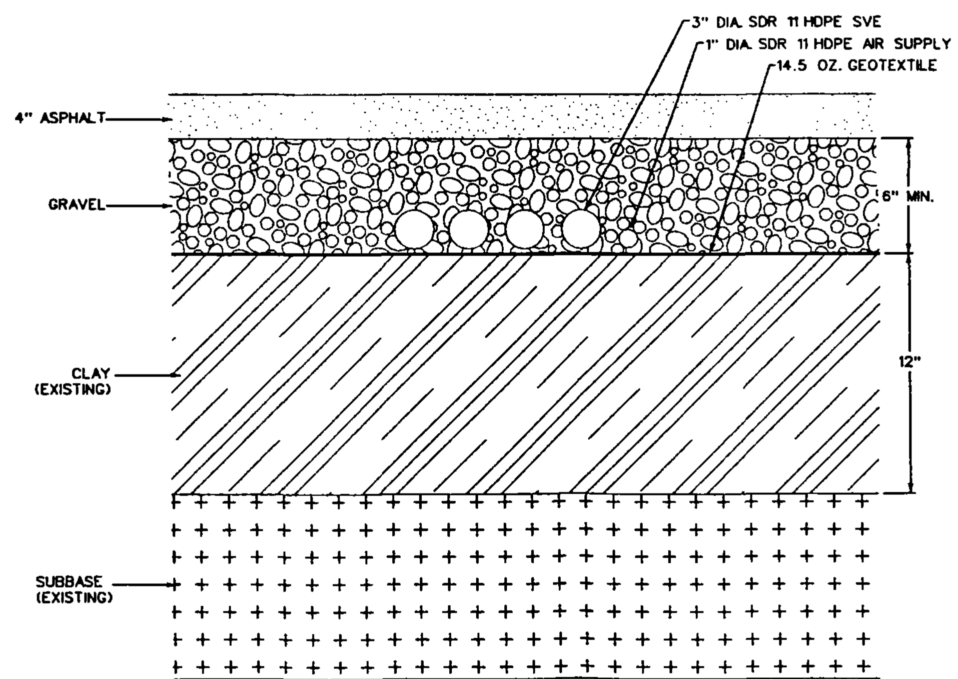
SOIL VAPOR EXTRACTION WELL (STICKUP)(SBPA)
FINAL CONSTRUCTION
NOT TO SCALE

3
FIG. 7



SOIL VAPOR EXTRACTION WELL (FLUSH-MOUNT)(SBPA)
FINAL CONSTRUCTION
NOT TO SCALE

4
FIG. 7



NOTE: EACH PIPE IS INDIVIDUALLY WRAPPED ALONG ITS LENGTH WITH 14.5 OZ. GEOTEXTILE FOR PROTECTION.

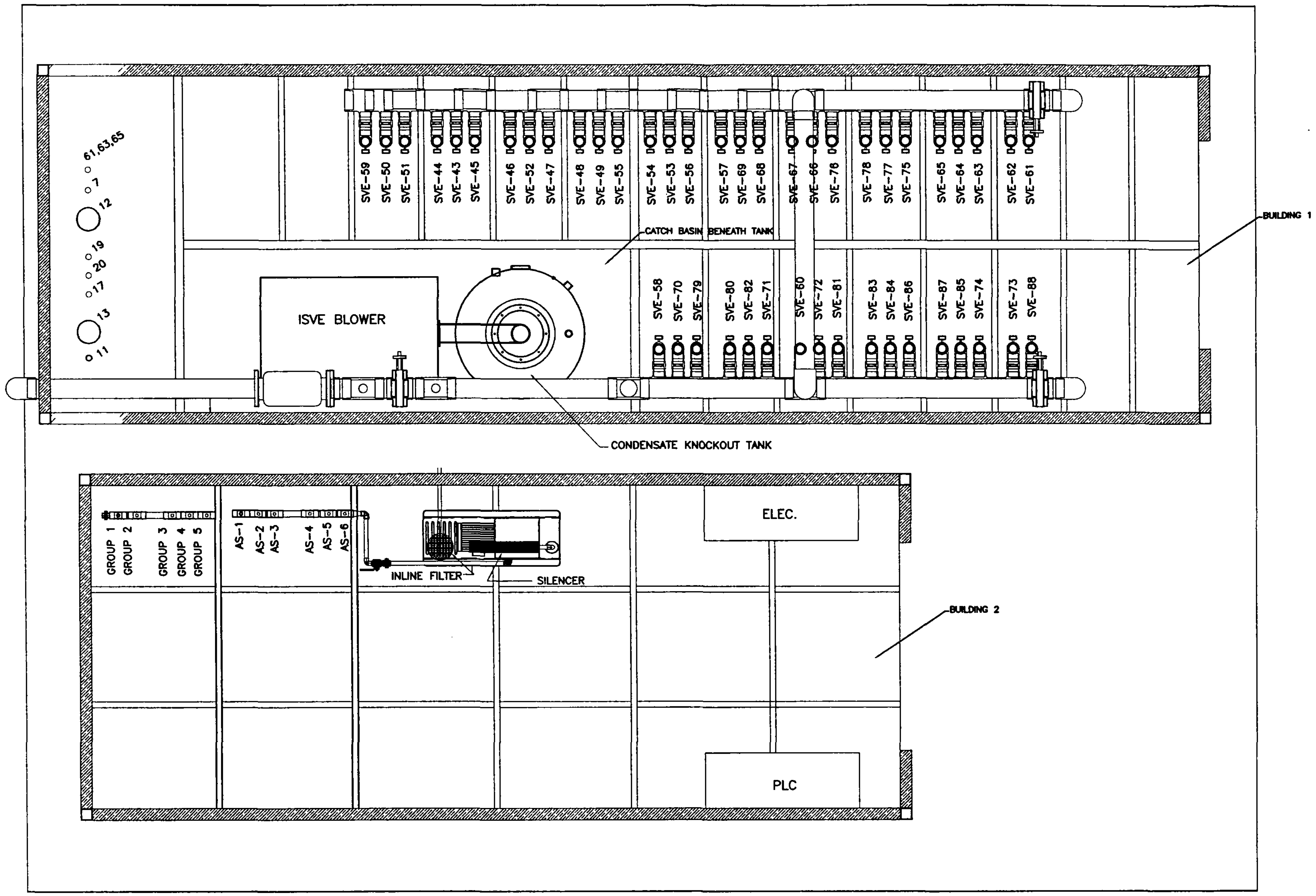
TYPICAL PIPING RUN
NOT TO SCALE

1
FIG. 8

NOTE: SURVEY COORDINATES, WELL DEPTHS, AND SCREEN LENGTHS ARE INCLUDED IN FIGURE 7 OF THIS REPORT.

File: \\Uschi4s02\Warrenville\jobs\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\SBPA Details 1.dgn
Plot Date: 17-MAR-2005

REV	DATE	BY	DESCRIPTION	SCALE	WARNING		SUBMITTED BY						FIGURE
				NONE	0 ½ 1 IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE	DESIGNED CAD DRAWN MM CHECKED RAA	ROBERT A. ADAMS (PROJECT MANAGER) PETER J. VAGT (COMPANY OFFICER)	LICENSE NO. LICENSE NO.	DATE DATE	MWH	ACS RD/RA GROUP AMERICAN CHEMICAL SERVICE SUPERFUND SITE GRIFFITH, INDIANA	ISVE SYSTEMS O&M MANUAL SBPA ISVE SYSTEM DETAILS - SBPA ISVE WELLS	9



REV	DATE	BY	DESCRIPTION

SCALE: N.T.S.

WARNING: 0 1/2 1 — IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

DESIGNED CAD
DRAWN MM
CHECKED RAA

SUBMITTED BY
ROB A. ADAMS (PROJECT MANAGER) LICENSE NO. DATE
PETER J. VAGT (COMPANY OFFICER) LICENSE NO. DATE

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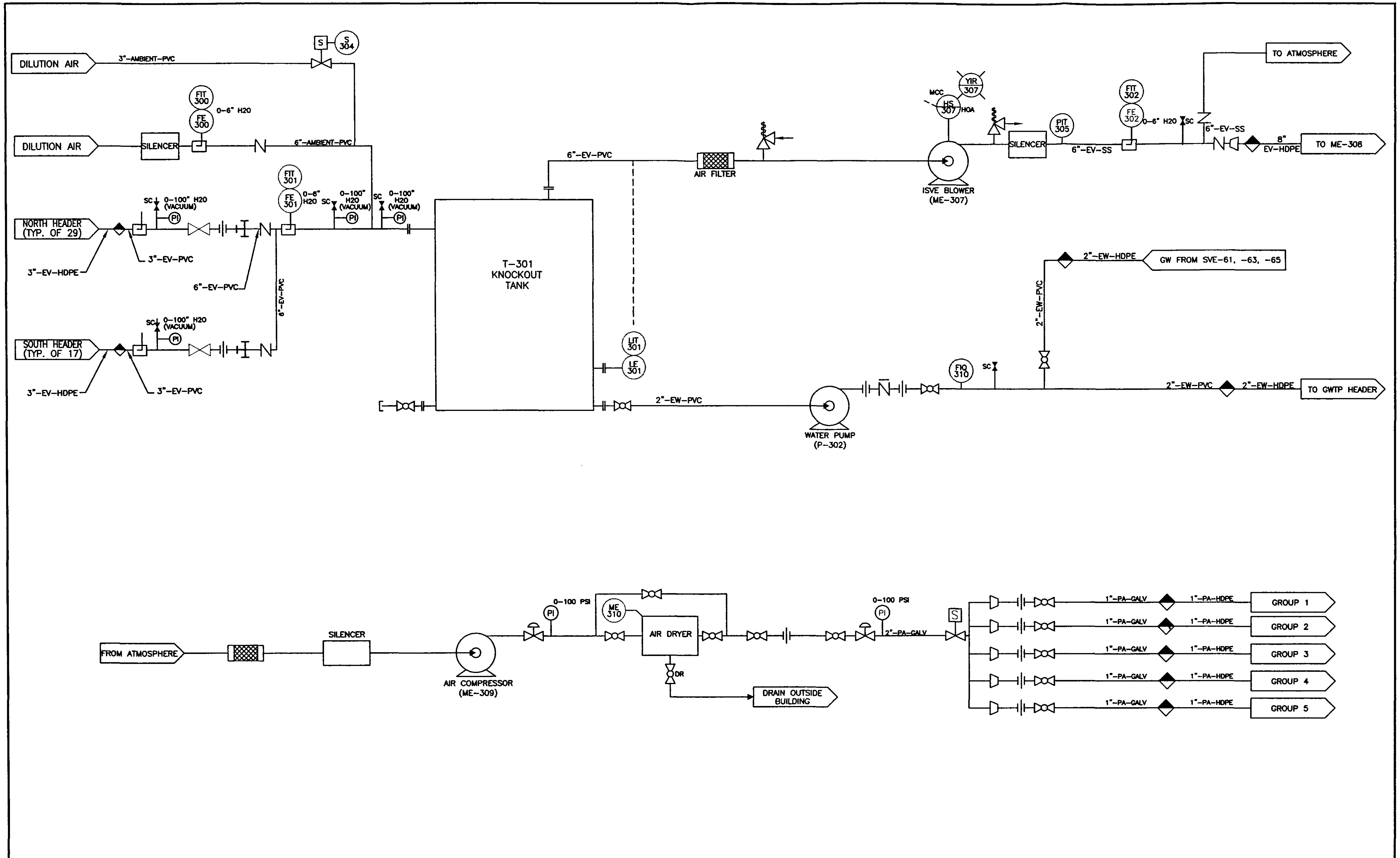
ISVE SYSTEMS O&M MANUAL

SBPA ISVE SYSTEM
BUILDING LAYOUT

FIGURE 12

J:\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\SBPA BUILDING LAYOUT.dwg Mar 17, 2005 - 9:58am



REV	DATE	BY	DESCRIPTION

SCALE: NOT TO SCALE

DESIGNED CAD
DRAWN MM
CHECKED RAA

SUBMITTED BY
ROB A. ADAMS
(PROJECT MANAGER'S NAME) LICENSE NO. DATE
PETER J. VAGT
(COMPANY OFFICER'S NAME) LICENSE NO. DATE

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ACS RD/RA GROUP
AMERICAN CHEMICAL SERVICE SUPERFUND SITE
GRIFFITH, INDIANA

ISVE SYSTEM O&M MANUAL
SBPA ISVE SYSTEM
PROCESS FLOW DIAGRAM

FIGURE 11

J:\209\0601 ACS\0301 Engineering for O&M\ISVE Systems O&M Manual\Drawings\PROCESS FLOW.dwg Mar 17, 2005 - 9:52am

Attachment 1

Monitoring Forms (blank)

Off-Site Area ISVE System
Monitoring Form

American Chemical Service, NPL Site
Griffith, Indiana

Date:	Time:	Operator Initials:	Operator Signature:

1. K-P Area Manifold:

a. Wells:

	Active?	*Diff. Pressure ("H_2O)*	*Vacuum ("H_2O)*	*VOCs (ppm)*	*Moisture?*	*Comments*
SVE-1	☐				Y N	
SVE-2	☐				Y N	
SVE-3	☐				Y N	
SVE-4	☐				Y N	
SVE-5	☐				Y N	
SVE-6	☐				Y N	
SVE-7	☐				Y N	
SVE-8	☐				Y N	
SVE-9	☐				Y N	
SVE-10	☐				Y N	
SVE-11	☐				Y N	
SVE-12	☐				Y N	

b. Headers:

K-P Header 1			(SVE-10, -9, -12, -4, -2, -5)
K-P Header 2			(SVE-11, -8, -7, -3, -6, -1)

2. OFCA Manifold:

a. Wells:

	Active?	*Diff. Pressure ("H_2O)*	*Vacuum ("H_2O)*	*VOCs (ppm)*	*Moisture?*	*Comments*
SVE-13	☐				Y N	
SVE-14	☐				Y N	
SVE-15	☐				Y N	
SVE-16	☐				Y N	
SVE-17	☐				Y N	
SVE-18	☐				Y N	
SVE-19	☐				Y N	
SVE-20	☐				Y N	
SVE-21	☐				Y N	
SVE-22	☐				Y N	
SVE-23	☐				Y N	
SVE-24	☐				Y N	
SVE-25	☐				Y N	
SVE-26	☐				Y N	
SVE-27	☐				Y N	
SVE-28	☐				Y N	
SVE-29	☐				Y N	
SVE-30	☐				Y N	
SVE-31	☐				Y N	
SVE-32	☐				Y N	
SVE-33	☐				Y N	
SVE-34	☐				Y N	
SVE-35	☐				Y N	
SVE-36	☐				Y N	
SVE-37	☐				Y N	
SVE-38	☐				Y N	
SVE-39	☐				Y N	
SVE-40	☐				Y N	
SVE-41	☐				Y N	
SVE-42	☐				Y N	

b. Headers:

OFCA Header 1		(SVE-17, -21, -14, -29, -24, -30, -38, -41, -35, -31)
OFCA Header 2		(SVE-16, -20, -18, -28, -25, -13, -36, -42, -37, -32)
OFCA Header 3		(SVE-15, -19, -26, -23, -27, -22, -34, -40, -39, -33)

Off-Site Area ISVE System
Monitoring Form

American Chemical Service, NPL Site
Griffith, Indiana

3. Air Sparge Points:

	Active?	*Flow Rate (scfm)*	*Pressure (" H2O)*	*Comments*
AS-7	☐			
AS-8	☐			
AS-9	☐			

4. Main Header:

	Blower Shed 1	*Blower Shed 2*
a. Dilution Header:		
Differential Pressure ("H_2O):		
Valve position:		
b. Combined Influent (located at knockout tank inlet):		
Differential Pressure ("H_2O):		
Vacuum ("H_2O):		
c. Blower Influent:		
Temperature (^oF):		
d. Blower Effluent:		
Differential Pressure ("H_2O):		
Pressure ("H_2O):		
Pressure (psi):		(Pressure Transmitter)
Temperature (^oF):		

5. Filter:

a. Differential Pressure across element ("H_2O):

b. Was filter changed? (Y/N):

6. Weather (from www.weather.com):

a. Temperature (^oF):

b. Humidity (%):

c. Barometric Pressure ("Hg):

d. General Conditions:

7. Comments:

CC: Site File

SBPA ISVE System
Monitoring Form
American Chemical Service, NPL Site
Griffith, Indiana

Date:	Time:	Operator Initials:	Operator Signature:

1. On-Site Area Manifold:

a. Wells:

	Active?	Diff. Pressure ($''H_2O$)	Vacuum ($''H_2O$)	VOCs (ppm)	Moisture?	Comments
SVE-43	☐				Y N	
SVE-44	☐				Y N	
SVE-45	☐				Y N	
SVE-46	☐				Y N	
SVE-47	☐				Y N	
SVE-48	☐				Y N	
SVE-49	☐				Y N	
SVE-50	☐				Y N	
SVE-51	☐				Y N	
SVE-52	☐				Y N	
SVE-53	☐				Y N	
SVE-54	☐				Y N	
SVE-55	☐				Y N	
SVE-56	☐				Y N	
SVE-57	☐				Y N	
SVE-58	☐				Y N	
SVE-59	☐				Y N	
SVE-60	☐				Y N	
SVE-61	☐				Y N	
SVE-62	☐				Y N	
SVE-63	☐				Y N	
SVE-64	☐				Y N	
SVE-65	☐				Y N	
SVE-66	☐				Y N	
SVE-67	☐				Y N	
SVE-68	☐				Y N	
SVE-69	☐				Y N	
SVE-70	☐				Y N	
SVE-71	☐				Y N	
SVE-72	☐				Y N	
SVE-73	☐				Y N	
SVE-74	☐				Y N	
SVE-75	☐				Y N	
SVE-76	☐				Y N	
SVE-77	☐				Y N	
SVE-78	☐				Y N	
SVE-79	☐				Y N	
SVE-80	☐				Y N	
SVE-81	☐				Y N	
SVE-82	☐				Y N	
SVE-83	☐				Y N	
SVE-84	☐				Y N	
SVE-85	☐				Y N	
SVE-86	☐				Y N	
SVE-87	☐				Y N	
SVE-88	☐				Y N	

b. Headers:

North Header		
South Header		

SBPA ISVE System
Monitoring Form

American Chemical Service, NPL Site
Griffith, Indiana

3. Air Sparge Points:

	Active?	Flow (scfm)	Pressure (" H2O)	Comments
AS-1	☐			
AS-2	☐			
AS-3	☐			
AS-4	☐			
AS-5	☐			
AS-6	☐			

4. Main Header:

a. Dilution Header:
Differential Pressure ("H_2O):
Valve position:

b. Combined Influent (located at knockout tank inlet):
Differential Pressure ("H_2O):
Vacuum ("H_2O):

c. Blower Influent:
Temperature (°F):

d. Blower Effluent:
Differential Pressure ("H_2O):
Pressure ("H_2O):
Temperature (°F):

5. Filter:

a. Differential Pressure across element ("H_2O):

b. Was filter changed? (Y/N):

6. Weather (from www.weather.com):

a. Temperature (°F):

b. Humidity (%):

c. Barometric Pressure ("Hg):

d. General Conditions:

7. Comments:

CC: Site File

Durr Thermal Oxidizer/Scrubber (ThermOx 1)
Operational Inspection Form
American Chemical Service, NPL Site
Griffith, Indiana

Date:	Time:	Operator Initials:	Operator Signature:

1. Vapor Sources:

- [ ] Off-Site ISVE
- [ ] SBPA ISVE
- [ ] T102 Vapors

2. Influent Manifold:

a. Influent Air Temp (°F):	1		
b. Air Flow (x100 cfm):	2		
c. Pressure ("H_2O):	3		

3. Scrubber:

a. Air Temp (°F):	4		(upper gauge)
b. Air Temp (°F)	5		(lower gauge)
c. Recirc. Flow (gpm):	6		
d. Recirc. Line Pressure (psi):	7		
e. Quench Spray Bar Flow (gpm):	8		(rotometer)
f. Quench Spray Bar Pressure (psi):	9		
g. Recirc. Pump Pressure (psi):	10		
h. Blowdown Volume (gallons):	11		(flow totalizer)
i. pH (units):	12		
j. Conductivity (mS/cm):	13		
k. Water Temp to HX (°F):	14		
l. Water Temp from HX to TOX1 (°F):	15		
m. Water Temp from HX to Catox (°F):			
n. High Press. Nozzle Pressure (psi):			
o. High Press. Nozzle Flow (gpm):			

4. Thermal Oxidizer (outside on unit);

a. Process Fan Eff Pressure ("H_2O):	16		d. Gas Train Pressures:			
b. Combust. Fan Eff Pressure ("H_2O):	17			Gauge 19 ("H_2O):	19	
c. Natural Gas Volume (rdg x100=ft^3):				Gauge 20 (psi):	20	
Temp-compensated:	18			Gauge 21 ("H_2O):	21	
Non-compensated:	18			Gauge 22 ("H_2O):	22	

5. Control Panel:

a. Burner Controller Temp (°F):	23		(top left)
b. Burner High Temp Limit (°F):	24		(top middle)
c. Scrubber Temp (°F):	25		(top right)

6. SCADA Computer:

a. Oxidizer Exhaust Temp (°F):	26	

7. Comments:

26 Instrument Number

CC: Site File

Global Thermal Oxidizer/Scrubber (ThermOx 2)
Operational Inspection Form

American Chemical Service, NPL Site
Griffith, Indiana

Date:	Time:	Operator Initials:	Operator Signature:

1. Vapor Sources:

- ☐ Off-Site ISVE
- ☐ SBPA ISVE
- ☐ T102 Vapors

2. Thermal Oxidizer (outside on unit):

a. Natural Gas Volume (rdg x100=ft^3):	1	
b. Pilot line pressure (psi):	2	

3. Scrubber (on unit):

a. Spray Header Flow (gpm):	3	
b. Spray Header Pressure (psi)	4	
c. Blowdown Flow (gpm):	5	
d. Quench Flow (gpm):	6	
e. Quench Pressure (psi):	7	
f. Pump Effluent Pressure (psi):	8	
g. Emergency Spray Pressure (psi):	9	

4. Control Panel:

a. Chamber Temp (^oF):	10	
b. Ox Out Temp (^oF):	11	
c. Scrubber Temp (^oF):	12	
d. pH (units):	13	
e. Conductivity (mS):	14	
f. Scrubber Level (inches):	15	
g. System Pressure ("w.c.):	16	
h. System Flow (SCFM):	17	
i. Blowdown Total (gal):	18	

5. Comments:

26 Instrument Number

CC: Site File

Quarterly
Groundwater Level Gauging Form

	Well	Vac. (H/M/L)	DTL (feet)	DTB (feet)	Wet/ Dry (W/D)	Contents (W/P/S/PS)	PID (ppm)	Comments
Off-Site Area ISVE Wells								
	SVE-1							
	SVE-4							
	SVE-8							
	SVE-13							
	SVE-15							
	SVE-18							
	SVE-20							
	SVE-24							
	SVE-29							
	SVE-31							
	SVE-34							
	SVE-37							
	SVE-40							
	AS-7							
	AS-8							
	AS-9							
	P-36							
SBRA ISVE W[illegible]								
	SVE-44							
	SVE-46							
	SVE-49							
	SVE-53							Product recovery well
	SVE-56							
	SVE-59							
	SVE-62							Product recovery well
	SVE-65							
	SVE-69							
	SVE-72							Product recovery well
	SVE-73							
	SVE-77							
	SVE-79							
	SVE-82							
	SVE-86							
	AS-1							
	AS-2							
	AS-3							
	AS-4							
	AS-5							
	AS-6							

Note:
Vacuum (Vac).: H = High, M = Moderale, L = Low
DTL = Depth to Liquid
DTB = Depth to bottom
BZ = Breathing Zone
Wet/Dry: W = Wet, D = Dry
Contents: W = Water, P = Product, S = Silt, PS = Product Sludge
A = Approximate Depth

Names______________________________
Date/Time ______________________________
System On/Off ____________________________
Weather:
Precipitation: Rain Sleet Snow Hail
Temperature Degrees: < 30 <60 <90
Barrometric Pressure: _________ **Trend:** ← ↓ ↑
Wind Direction: ____________ **Speed:** ____________

Monthly
Groundwater Level Gauging Form

	Well	Vac. (H/M/L)	DTL (feet)	DTB (feet)	Wet/ Dry (W/D)	Contents (W/P/S/PS)	PID (ppm)	Comments
Off-Site Area ISVE Wells								
	AS-7							
	AS-8							
	AS-9							
	P-36							
SBPA ISVE Wells								
	AS-1							
	AS-2							
	AS-3							
	AS-4							
	AS-5							
	AS-6							
.								

Note:
Vacuum (Vac).: H = High, M = Moderale, L = Low
DTL = Depth to Liquid
DTB = Depth to bottom
BZ = Breathing Zone
Wet/Dry: W = Wet, D = Dry
Contents: W = Water, P = Product, S = Silt, PS = Product Sludge
A = Approximate Depth

Names____________________________
Date/Time ____________________________
System On/Off ____________________________
Weather:
Precipitation: Rain Sleet Snow Hail
Temperature Degrees: < 30 <60 <90
Barrometric Pressure: _________ **Trend:** ← ↓ ↑
Wind Direction: ___________ **Speed:** ___________

Attachment 2

Health & Safety Procedures – Water Level Gauging within Contaminated Source Areas (MWH Memorandum dated June 26, 2003)

Health & Safety Procedures
Water Level Gauging within Contaminant Source Areas
Revision Date: June 26, 2003
ACS NPL Site, Griffith, Indiana

Activities. These Health and Safety Procedures are for water level gauging in the Site areas designated as the Still Bottoms Pond Area (SBPA), the Off-Site Containment Area (OFCA), and the Kapica-Pazmey Area (K-P Area). These areas constitute the main Contaminant Source Areas at the site. The specific water level gauging points that are currently monitored routinely are listed by area in the attached Table 1.

Scope of Document. These Health and Safety Procedures were developed to minimize the potential risk of contaminant exposure via inhalation and dermal contact while conducting the activities detailed above and were developed using information from the following existing Health and Safety Plans (HASPs) for the site;

1) *Site Safety Plan, Pre-Design Investigation, American Chemical Service, Inc.*, Montgomery Watson, January 1996.

2) *Site Safety Plan Addendum, American Chemical Service Superfund Site*, Montgomery Watson, January 1999.

3) *Site Safety Plan Addendum, Long-Term Groundwater Monitoring Plan, American Chemical Service Superfund Site*, MWH, September 2002.

The three documents listed above provide details on other risks potentially present at the site. Therefore, these Health and Safety Procedures are to be used in conjunction with the three HASPs.

Identification of Potential Risks. The potential risks include dermal or inhalation exposure to site contaminants in either vapor or free-phase liquid form. Additional information and specifics on the potential contaminants are provided in the three Site HASPs listed above.

Equipment. Personal protective equipment (PPE) requirements conform to the Level C PPE detailed in Section 6.2 of the *Site Safety Plan Addendum* (1999) and are summarized below:

- Chemical-resistant nitrile or latex gloves.
- Steel-toed boots
- Hard Hat
- Safety glasses when not wearing full-face respirator
- Full-face or half-face air purifying respirator with appropriate organic vapor cartridges.
- Chemical-resistant coveralls (Tyvek or SARANEX) (optional)
- Chemical-resistant over-boots (optional)

The following equipment is required/recommended:

- Photoionization detector (PID) or flame-ionization detector (FID)
- Paper towels and a spray bottle of cleaning agent (Simple Clean, Orange Clean, etc.) to clean water level sensor
- Plastic container with lid and/or sealable bags (zip-loc, etc) to reduce/contain odors/vapors transport or soiled equipment in a manner to reduce/contain odor.
- Cellular phone for emergency contact purposes (use upwind and away from open well covers)
- Ventilator fan (optional)

Procedures. The following are task-specific health requirements procedures that should be followed in addition to the requirements/procedures in the three site HASPs. Note that OSHA 40-hour training certificate, current medical and OSHA 8-hour certificates, and documentation of a site-specific respirator fit test are to be on file with Lee Orosz at the site prior to performing these activities. Also, the field tasks should be performed using the "buddy system" with both people staying within each other's line of sight. The following outlines the water level sequence of tasks:

1) Upon arriving at the site, sign in at the groundwater treatment plant.
2) Calibrate PID/FID.
3) Discuss with Tom Tinics or Chris Daly if there have been any changes in operation of any of the in-situ soil vapor extraction (ISVE) systems since the last water level gauging event. Changes include, but are not limited to start-up or shutdown of the system or a change in the operating wells. These changes could effect the subsurface conditions and subsequently change contaminant constituents and concentrations.
4) Install new organic vapor cartridges in each worker's respirator.
5) Don PPE (excluding respirator and nitrile gloves).
6) Proceed to work area.
7) Observe windsock direction and plan work so that workers remain upwind or perpendicular to the wind direction (when facing the monitoring point).
8) Observe and document the operational status (on/off) of the ISVE system in the area that you are working. The operational status can be determined by listening for the sound of the blower at the blower shed. If the system is in a different state than discussed with the operator (Step 3), contact operator prior to continuing work.
9) Don respirator and nitrile gloves.
10) If using the ventilator fan, place the fan so that it pushes air past the monitoring point in the downwind direction and away from the workers and turn the fan on prior to removing the monitoring point cap. The fan will help to dissipate potential vapors at the monitoring point.
11) Remove well cap while staying upwind or perpendicular to the wind direction (when facing the monitoring point).

12) Place the sensor point of the PID/FID in the anticipated breathing zone above the well head. Hold PID/FID until readings stabilize for a minimum of 30 seconds to allow volatile contaminants that may be present to reach PID/FID. The following table contains a summary of the appropriate PPE/actions based on the observed PID/FID readings:

PID/FID Reading	PPE/Action
<5 ppm	May down grade to Level D PPE as detailed in Section 6.1 of the *Site Safety Plan Addendum* (1999). Collect the water level measurement as required.
5 – 9.99 ppm	Stay in Level C PPE as detailed in Section 6.1 of the *Site Safety Plan Addendum* (1999) and summarized above. Collect water level measurement as required. Remain in Level C PPE until monitoring point is closed and probe has been cleaned or placed in sealed container.
>10 ppm	Close well immediately. Document that water level was not measured and discuss with Engineering Manager for appropriate future course of action.

13) Collect water level measurement while upwind or perpendicular to the wind direction (when facing the monitoring point).
14) Close well cap.
15) Clean equipment and place waste (paper towels, etc.) and water level sensor in sealed bags or covered plastic container to minimize exposure.
16) Remove Level C PPE, if applicable.

Exposure symptoms. Typical inhalation exposure systems for organic compounds may include headache; dizziness; watery eyes; loss of coordination; nose, mouth, and throat irritation; fatigue, labored breathing; and vomiting. Typical systems of dermal contact for organic compounds may include redness, burning sensation, and lesions. A detailed listing of symptom by individual compound is included in Table 2-2 of the *Site Safety Plan Addendum* (1999).

Emergency Information. In case of emergency or if you experience any of the symptoms listed above, immediately contact the Site Safety Officer (Lee Orosz). If the Site Safety Officer cannot be contacted, then contact Munster Community Hospital (directly or by 911). Arrangements should be made for transportation to the hospital and an emergency room visit should be made. **DO NOT DRIVE YOURSELF.**

Site Safety Officer:	Lee Orosz Phone: (219) 924-4607 Cell: (219) 218-1329
Hospital:	Munster Community Hospital 901 McArthur Boulevard Munster, Indiana Phone: (219) 836-1600
Emergency:	911

RAA/PJV/CAS/raa/ams
J:\209\0601 ACS\Health and Safety\ISVE Well Gauging HS Procedures.doc

Table 1
Interim Health Safety Procedures
Water Level Gauging within Contaminant Source Areas
ACS NPL Site, Griffith, Indiana

Off-Site Containment Area	
ID	**Type**
ISVE- 13	ISVE Well
ISVE- 14	ISVE Well
ISVE- 15	ISVE Well
ISVE- 16	ISVE Well
ISVE- 17	ISVE Well
ISVE- 18	ISVE Well
ISVE- 19	ISVE Well
ISVE- 20	ISVE Well
ISVE- 21	ISVE Well
ISVE- 22	ISVE Well
ISVE- 23	ISVE Well
ISVE- 24	ISVE Well
ISVE- 25	ISVE Well
ISVE- 26	ISVE Well
ISVE- 27	ISVE Well
ISVE- 28	ISVE Well
ISVE- 29	ISVE Well
ISVE- 30	ISVE Well
ISVE- 31	ISVE Well
ISVE- 32	ISVE Well
ISVE- 33	ISVE Well
ISVE- 34	ISVE Well
ISVE- 35	ISVE Well
ISVE- 36	ISVE Well
ISVE- 37	ISVE Well
ISVE- 38	ISVE Well
ISVE- 39	ISVE Well
ISVE- 40	ISVE Well
ISVE- 41	ISVE Well
ISVE- 42	ISVE Well
AS- 7	Air Sparge Point
AS- 8	Air Sparge Point
AS- 9	Air Sparge Point

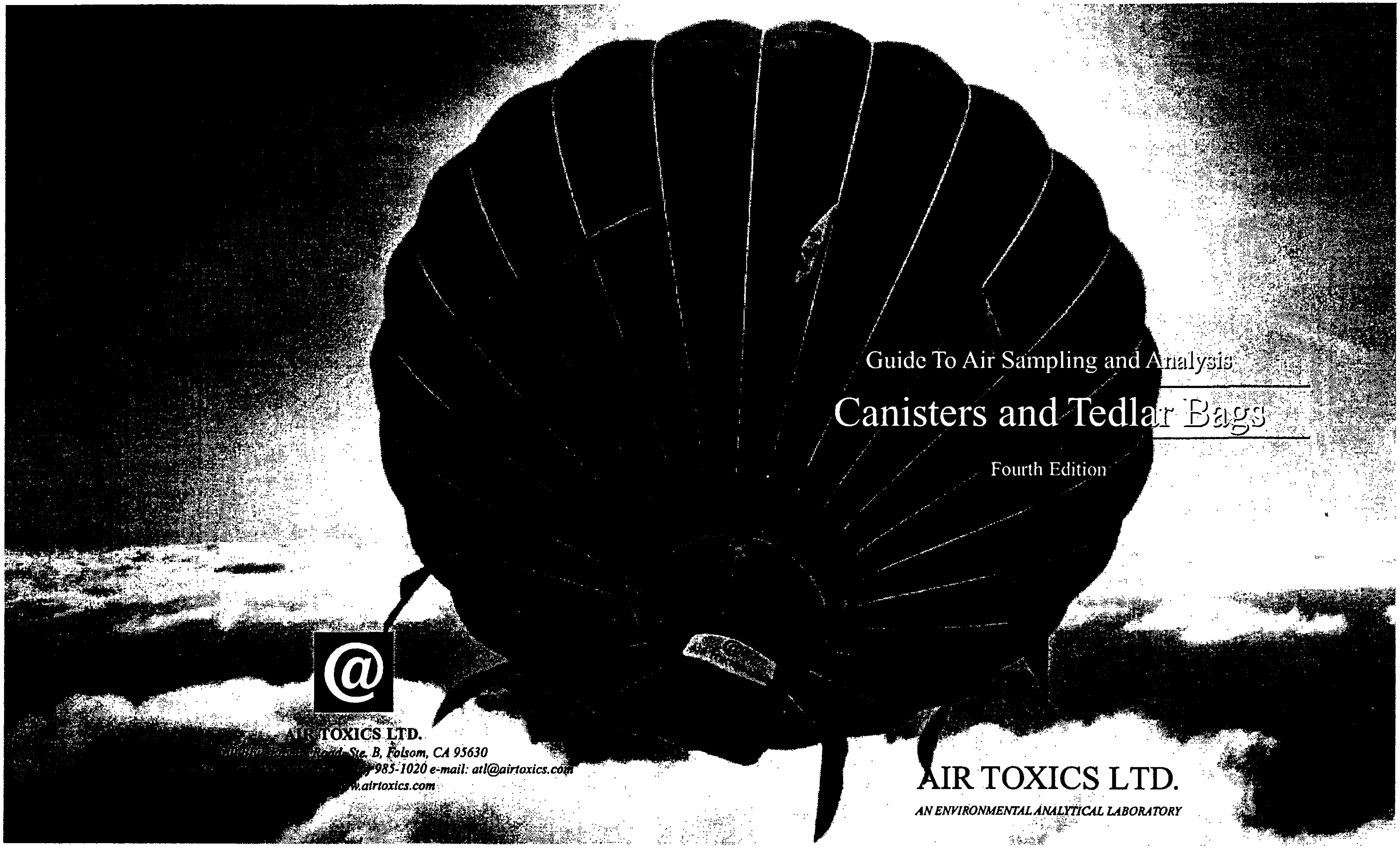
Still Bottoms Pond Area	
ID	**Type**
ISVE- 43	ISVE Well
ISVE- 44	ISVE Well
ISVE- 45	ISVE Well
ISVE- 46	ISVE Well
ISVE- 47	ISVE Well
ISVE- 48	ISVE Well
ISVE- 49	ISVE Well
ISVE- 50	ISVE Well
ISVE- 51	ISVE Well
ISVE- 52	ISVE Well
ISVE- 53	ISVE Well
ISVE- 54	ISVE Well
ISVE- 55	ISVE Well
ISVE- 56	ISVE Well
ISVE- 57	ISVE Well
ISVE- 58	ISVE Well
ISVE- 59	ISVE Well
ISVE- 60	ISVE Well
ISVE- 61	ISVE Well
ISVE- 62	ISVE Well
ISVE- 63	ISVE Well
ISVE- 64	ISVE Well
ISVE- 65	ISVE Well
ISVE- 66	ISVE Well
ISVE- 67	ISVE Well
ISVE- 68	ISVE Well
ISVE- 69	ISVE Well
ISVE- 70	ISVE Well
ISVE- 71	ISVE Well
ISVE- 72	ISVE Well
ISVE- 73	ISVE Well
ISVE- 74	ISVE Well
ISVE- 75	ISVE Well
ISVE- 76	ISVE Well
ISVE- 77	ISVE Well
ISVE- 78	ISVE Well
ISVE- 79	ISVE Well
ISVE- 80	ISVE Well
ISVE- 81	ISVE Well

Still Bottoms Pond Area (cont)	
ID	**Type**
ISVE- 82	ISVE Well
ISVE- 83	ISVE Well
ISVE- 84	ISVE Well
ISVE- 85	ISVE Well
ISVE- 86	ISVE Well
ISVE- 87	ISVE Well
ISVE- 88	ISVE Well
AS- 1	Air Sparge Point
AS- 2	Air Sparge Point
AS- 3	Air Sparge Point
AS- 4	Air Sparge Point
AS- 5	Air Sparge Point
AS- 6	Air Sparge Point
P- 36	Piezometer

Kapica-Pazmey Area	
ID	**Type**
ISVE- 1	ISVE Well
ISVE- 2	ISVE Well
ISVE- 3	ISVE Well
ISVE- 4	ISVE Well
ISVE- 5	ISVE Well
ISVE- 6	ISVE Well
ISVE- 7	ISVE Well
ISVE- 8	ISVE Well
ISVE- 9	ISVE Well
ISVE- 10	ISVE Well
ISVE- 11	ISVE Well
ISVE- 12	ISVE Well

Attachment 3

***Guide to Air Sampling and Analysis* and**
Guide to Sorbent-Based Sampling Volatiles and Semi-Volatiles
(Air Toxics Inc.)



Guide To Air Sampling and Analysis
Canisters and Tedlar Bags
Fourth Edition
AIR TOXICS LTD.
AN ENVIRONMENTAL ANALYTICAL LABORATORY
AIR TOXICS LTD.
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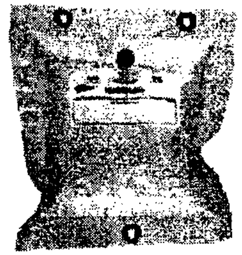
 

Table of Contents

Tables

Section 1.0 Introduction

Air Toxics Ltd. presents this guide as a resource for individuals engaged in air sampling. Air sampling can be more involved than water or soil sampling due to the reactivity of chemical compounds in the gas matrix and sample interaction with the sampling equipment and media. Ensuring that air samples are collected properly is an important step in acquiring meaningful analytical results. This guide is not a substitute for experience and cannot possibly address the multitude of actual field conditions. Note that this guide is intended for typical projects involving whole air sampling of volatile organic compounds (VOCs) in canisters and Tedlar bags. Air Toxics Ltd. provides the "Guide to Air Sampling and Analysis - Sorbents, Solutions, and Filters" for other types of sampling.

1.1 Whole Air Sampling of VOCs

There are four general ways to collect compounds in a gas phase sample. A sampler can collect the gas in a container or draw the gas through a sorbent, solution, or filter. This guide focuses on collecting a sample in the most common air sampling containers, Summa canisters and Tedlar bags. The sample can be collected in the container either passively (i.e., by evacuating the canister prior to sampling) or actively (i.e., using a pump). The container is subsequently sealed and transported to the laboratory for analysis. The sample is referred to as a "whole air sample" and the compounds remain in the gas matrix (e.g., ambient air) inside the container.

As a general rule, whole air sampling is best when target compounds are volatile, non-polar, and have boiling points less than 170°C, although exceptions to this rule can be found. Recovery of any given compound in a whole air sample is very much dependent upon the humidity of the sample, the chemical activity of the sample matrix, and the degree of inertness of the container.

1.2 Choosing Between Canisters and Tedlar Bags

Deciding whether a canister or a Tedlar bag should be used for collecting a whole air sample depends on the type of air sampling application. The Tedlar bag is best used as a "ppmv" (parts per million by volume) whole air sample container. In other words, it is best suited for air sampling applications involving compound concentrations well above the low ppbv (parts per billion by volume) range. Soil/landfill gas surveys, monitoring soil vapor extraction (SVE) systems, and sampling for atmospheric/fixed gases are applications well suited for Tedlar bag sampling. Ambient and indoor air projects driven by risk assessment or litigation are better suited for Summa canisters that are cleaned and individually certified free of the target compounds. The different degree of compound inertness between the two sample container surfaces is reflected in their suggested hold times for VOCs – 3 days from sampling to analysis for a Tedlar bag compared to 14-30 days for a Summa canister. Analyses of new Tedlar bags reveal that some VOCs may be present at concentrations in the single digit ppbv range (see Section 3).

Table 1.2. Comparison of Canisters to Tedlar Bags

	Canisters	Tedlar Bags
Common Volumes	1 and 6 L	1, 3, and 5 L
Type of Sampling	Passive (vacuum)	Active (pump required)
Sample Handling	Room temperature	Room temperature
Media Hold Time	Up to 30 days recommended	Indefinite
Hold Time to Analysis	14-30 days	3 days
Surface Inertness	Excellent	Fair
Cleanliness	10% or 100% certified to ppbv/pptv levels	Some VOCs present at 0.5 to 45 ppbv
Sampling Application	Ambient/indoor air, soil/landfill gas, stationary source	Ambient air (fixed gases only), soil/landfill gas, stationary source
Rule of Thumb	"ppbv device"	"ppmv device"
Advantages	Inertness, hold time, ruggedness, no pump	Purchase/shipping cost, availability, convenience

The table above compares the features of canisters and Tedlar bags. Canisters have superior inertness, hold time to analysis, ruggedness, and do not require a sampling pump. Tedlar bags can be purchased inexpensively in bulk, carried to a sampling site in a briefcase, filled in seconds, and shipped easily to the laboratory for analysis. Call Client Services at 800-985-5955 if you have questions regarding sampling media.

1.3 Organization of this Guide

The remainder of this guide is divided into three sections: canister sampling, Tedlar bag sampling, and special sampling considerations. Section 2 on canister sampling and Section 3 on Tedlar bag sampling provide complete sampling media descriptions, practical considerations for sampling, and step-by-step sampling procedures. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister or Tedlar bag sample. Section 4 provides considerations for special sampling configurations such as field duplicates and ambient blanks. This section also provides considerations for sampling at altitude, soil/landfill gas sampling, and sample cylinder (or "sample bomb") sampling.

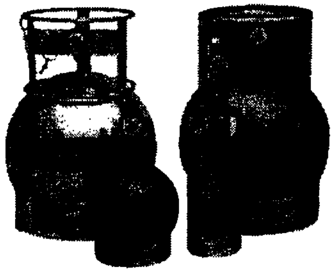
If you have any questions after reading this guide, please call Client Services at 800-985-5955 before proceeding with sampling. Air Toxics Ltd. also provides technical articles on specific air topics in *Air Topics* publications and *In the Air* quarterly newsletters available upon request or on the Internet at *www.airtoxics.com.*

Section 2. Canister Sampling

This section provides a description of air sampling canisters, practical considerations for sampling, and step-by-step instructions for collecting a grab and integrated sample. Photographs illustrate the correct way to assemble the various sampling components. Tables provide detailed information on many operational factors that ultimately influence the quality of the data obtained from a canister sample.

2.1 Introduction to Canisters

An air sampling canister is a container for collecting a whole air sample for ambient and indoor air applications. The canister is best suited for projects involving analysis of compounds in the ppbv range. However, canisters can be used for other applications such as landfill and soil gas involving analysis of compounds in the ppmv range.



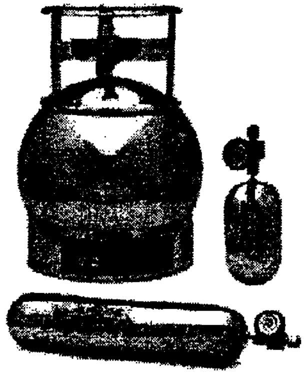
A canister can be spherical or cylindrical and is constructed of stainless steel. The canister is prepared for sampling by evacuating the contents to a vacuum of approximately 29.9 inches of Mercury (in. Hg). Opening the stainless steel bellows valve allows the air sample to enter the canister. When the target volume of sample is collected, the valve is closed and the canister is returned to the laboratory.

Canisters can range in volume from less than 1 liter (L) to greater than 6 L. At Air Toxics Ltd., 6 L canisters are used for ambient air samples and for taking integrated samples. 1 L canisters are normally used for taking high concentration (i.e., greater than 5 ppbv) grab samples, although exceptions to these guidelines are common. Variations of air sampling canisters include glass bulbs, sample cylinders (or "sample bombs"), and Summa canisters. Glass bulbs are rarely used in field applications due to lack of ruggedness. Sample cylinders are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end (see Section 4.4). The remainder of this section focuses on Summa canisters.

2.1.1 Summa Canister

A Summa canister is a stainless steel container that has had the internal surfaces specially passivated using a "Summa" process. This process combines an electropolishing step with a chemical deactivation step to produce a surface that is nearly chemically inert. A Summa surface has the appearance of a mirror: bright, shiny, and smooth. The degree of chemical inertness of a whole air sample container is crucial to minimizing reactions with the sample and maximizing recovery of target compounds from the container. Air Toxics Ltd. maintains a large inventory of Summa canisters in 6 and 1 L volumes.

2.1.2 Canister Cleaning and Hold Time



Canister sampling differs considerably from collecting a water sample in a VOA vial or a soil sample in an amber jar in that the container (valued at over $450) is cleaned and reused. A canister will hold a high vacuum (i.e., greater than 25 in. Hg) for more than 30 days. Air Toxics Ltd., however, requires that our canisters be returned within 30 days.

☞ Media hold time for a canister is 30 days

Air Toxics Ltd. provides two types of canister cleaning certification, 10% and 100%, depending upon the requirements of the project. The 10% certification process is appropriate for routine ambient air applications and high concentration applications such as soil vapor and landfill gas monitoring. The 10% certification process begins by cleaning canisters using a combination of dilution, heat, and high vacuum. After completing the cleaning steps, 10% of the canisters are certified each day. Canisters are certified for approximately 60 VOCs using GC/MS by Modified EPA Method TO-15. The 10% certification process requires that target compound concentrations be below 0.2 ppbv. Alternatively, the 100% certification (i.e., individual certification) process is appropriate for ambient and indoor air applications driven by risk assessment or litigation that require pptv (parts per trillion by volume) sensitivity. Similar to the 10% certification, the 100% certification also begins with the canister cleaning process. The difference with the 100% certification is that canisters are individually certified for a client-specific list of target compounds using GC/MS by TO-15. The 100% certified canisters are shipped with analytical documentation demonstrating that they are free of the target compounds down to the project reporting limits.

☞ Specify whether your project requires 10% or 100% canister cleaning certification

Although 14 days is the most commonly cited hold time for a canister sample, the hold time is compound specific. For example, non-polar compounds such as chloroform, benzene, and vinyl chloride are stable in a canister for at least 30 days. In fact, EPA Method TO-15 states: "Fortunately, under conditions of normal usage for sampling ambient air, most VOCs can be recovered from canisters near their original concentrations for after storage times of up to thirty days". However, recovery of polar compounds such as methanol and acetone begin to drop significantly after 14 days. Analysis of these samples should be performed within 14 days.

☞ Sample hold time to analysis for a canister is 14-30 days for VOCs

2.2 Associated Canister Hardware

Associated hardware used with the canister includes the valve, brass cap, particulate filter, and vacuum gauge.

2.2.1 Valve

An industry standard, 1/4 in. stainless steel bellows valve (manufactured by Nupro) is mounted at the top of the canister. The valve allows vacuum to be maintained in the canister prior to sampling and seals off the canister once the sample has been collected. No more than a half turn by hand is required to open the valve. Do not over-tighten the valve after sampling or it may become damaged. A damaged valve can leak and possibly compromise the sample. Some canisters have a metal cage near the top to protect the valve.

2.2.2 Brass Cap

Each canister comes with a brass cap (i.e., Swagelok 1/4 in. plug) secured to the inlet of the valve assembly. The cap serves two purposes. First, it ensures that there is no loss of vacuum due to a leaky valve or valve that is accidentally opened during handling. Second, it prevents dust and other particulate matter from fouling the valve. The cap is removed prior to sampling and replaced following sample collection.

☞ **Always replace the brass cap following canister sampling**

7 Micron

5 Micron

2.2.3 Particulate Filter

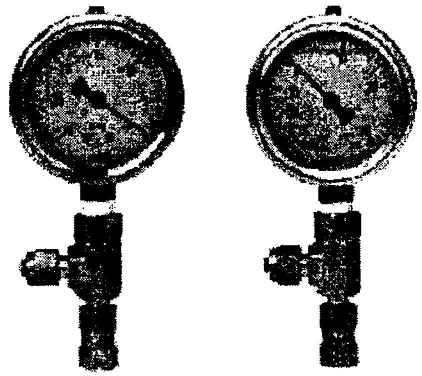
Each canister comes with a particulate filter provided separately in the packing box. The filter prevents particulate matter from fouling the valve (or flow controller) and entering the canister. Particulate filters should be cleaned between uses. Air Toxics Ltd. provides two types of particulate filters: 7 micron and 5 micron. The longer, 7 micron particulate filter is normally used with 6 L canisters and whenever an integrated sample is being collected. This device filters particulate matter greater than 7 microns in diameter and does not significantly restrict the flow rate in to the canister. Typical fill times for canisters are shown in the following table. The shorter, 5 micron particulate filter is often used to slow down grab sampling with 1 L canisters and mini-cans. This device is a fritted stainless steel disk that has been pressed into a conventional Swagelok adapter. This device filters particulate matter greater than 5 microns in diameter and has a relatively high pressure drop across the fritted disk. It restricts the flow into the canister and fill times are increased.

☞ **Always use the particulate filter for canister sampling**

Table 2.2.3 Fill Times for Canisters

CANISTER VOLUME	7 micron filter	5 micron filter
6 L	16 sec	23 min
1 L	3 sec	4 min
400 mL (mini-can)	1-2 sec	1 min 20 sec

2.2.4 Vacuum Gauge

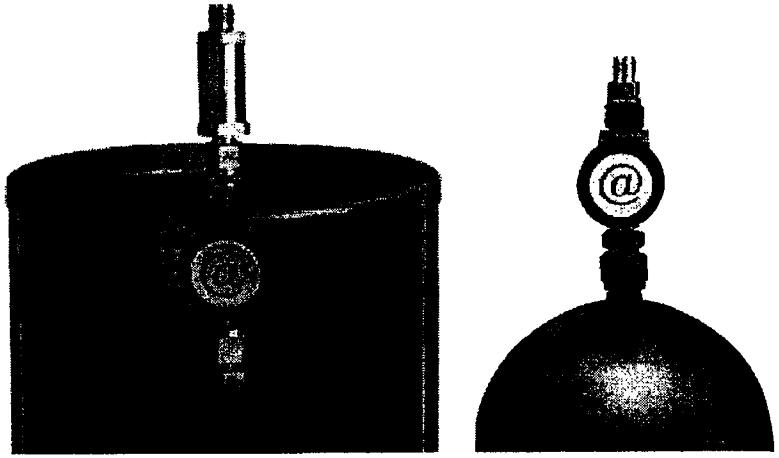


A vacuum gauge can be used to measure the initial vacuum of the canister before sampling and the final vacuum upon completion. A gauge can also be used to monitor the fill rate of the canister when collecting an integrated sample. Gauges are generally not used during the brief interval for grab sampling. Gauges are used only to provide a relative measure of "change". The accuracy of gauges provided by Air Toxics Ltd. is such that gauge-to-gauge comparisons have no merit. Individuals engaged in frequent air sampling or air projects driven by risk assessment or litigation are highly encouraged to purchase and maintain their own gauge. Upon request, Air Toxics Ltd. provides two types of gauges: vacuum gauges reading 0 to 30 in. Hg and vacuum-pressure gauges reading 30 in. Hg to 30 psig (pounds per square inch gage).

☞ **Air Toxics Ltd. provides gauges only if requested**

2.3 Grab Sampling with Canisters

There are two basic modes of canister sampling: grab and integrated. A grab sample is taken over a short interval (i.e., 1-5 minutes) while an integrated sample is taken over an extended period (e.g., 0.5-2 hours for a 1 L canister and 0.5-24 hours for a 6 L canister). In both modes the canister vacuum is used to draw sample into the canister. This is commonly referred to as passive sampling. Active sampling utilizes a pump to fill the canister. The most common hardware configuration used to take a grab sample are illustrated in the following figure. A particulate filter is used to prevent particulate matter from fouling the valve and entering the canister.



2.3.1 Considerations for Grab Sampling With Canisters

The following are some considerations for collecting a grab sample in a canister.

- **Avoid Leaks in Sampling Train**: All fittings on the sampling hardware are 1/4 in. Swagelok. A 9/16 in. crescent wrench is used to assemble the hardware. It is not necessary to over tighten the fittings; finger tight plus 1/4 turn with the wrench is adequate. In practice this should be tight enough so that the various pieces of equipment, when assembled, cannot be rotated by hand.

- **Verify Gauge Operation**: If the indicator does not read "zero" upon arrival, the gauge either needs to equilibrated or the gauge may be damaged and unusable. Equilibrate the gauge by "cracking" the rubber plug on top of the gauge. For more details on the equilibration procedure, see instructions included with the gauge or call Client Services at 800-985-5955.

- **Verify Initial Vacuum of Canister**: Prior to shipment, each canister is checked for mechanical integrity. However, it is still important to check the vacuum of the canister prior to use and record the initial vacuum on the chain-of-custody. The initial vacuum of the canister should be greater than 25 in. Hg. If the canister vacuum is less than 25 in. Hg, do not use it. Call Client Services at 800-985-5955 and arrange for a replacement canister. If sampling at altitude, there are special considerations for gauge readings and sampling (see Section 4.2). The procedure to verify the initial vacuum of a canister is simple, but unforgiving.

1. Confirm that valve is closed (knob should already be tightened clockwise)
2. Remove the brass cap
3. Attach gauge
4. Attach brass cap to side of gauge tee fitting
5. Open and close valve quickly (a few seconds)
6. Read vacuum on the gauge
7. Record gauge reading on "Initial Vacuum" column of chain-of-custody
8. Verify that canister valve is closed and remove gauge
9. Replace the brass cap

- **Leave Residual Vacuum**: A grab sample can be collected either by allowing the canister to reach ambient conditions or by leaving some residual vacuum (e.g., 5 in. Hg) in the canister. In either case, the final vacuum should be noted on the "Final Vacuum" column on the chain-of-custody. This will enable the laboratory to compare the final vacuum with the receipt vacuum (i.e., the vacuum measured upon arrival at the laboratory). If the two readings differ significantly, Client Services will contact you for instructions on how to proceed.

2.3.2 Step-by-Step Procedures for Canister Grab Sampling

These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

Before you get to the field:

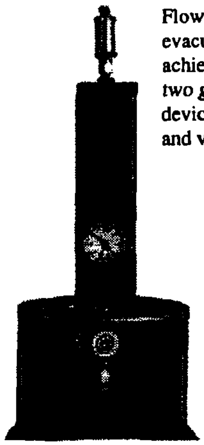
1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and gauge – if requested)
2. Verify that gauge is working properly (see Section 2.3.1)
3. Verify and record initial vacuum of canister (see Section 2.3.1)

When ready to sample:

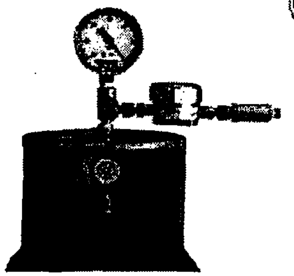
4. Remove brass cap
5. Attach particulate filter to canister
6. Open valve 1/2 turn (6 L canister normally takes about 16 sec to fill)
7. Close valve by hand tightening knob clockwise
8. Verify and record final vacuum of canister (repeat steps used to verify initial vacuum)
9. Replace brass cap
10. Fill out canister sample tag
11. Return canister in box provided
    - Unreturned canister charge of $450 each
12. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $45 per gauge
13. Fill out chain-of-custody and relinquish samples properly
14. Place chain-of-custody in box and retain pink copy
15. Tape box shut and affix custody seal (if applicable) across flap
16. Ship accordingly to meet method holding times

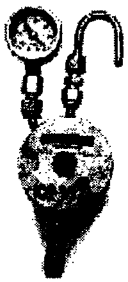
2.4 Integrated Sampling with Canisters and Flow Controllers

An air sample collected over more than a few minutes is referred to as an integrated sample and can provide information on compound concentrations in air averaged or composited over time. An 8- or 10-hour integrated sample can be used to determine indoor air quality in the workplace. Similarly, a 24-hour integrated sample can be an economical and practical approach to determine residential exposure to indoor or outdoor air sources. The most common hardware configurations used to take an integrated sample are illustrated below.



Flow controllers are devices that regulate the flow of air during sampling into an evacuated canister. Also known as flow restrictors, these devices enable a sampler to achieve a desired flow rate and thus, a sampling interval. Air Toxics Ltd. provides two general types of flow controllers: mass flow controllers and critical orifice devices. Both devices are driven by differential pressure between ambient conditions and vacuum in the canister.





Flow controller by Entech

Flow controller by Veriflo

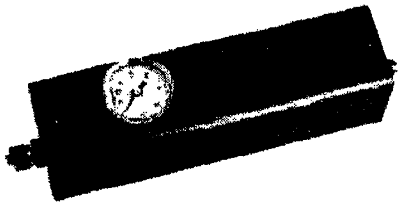
2.4.1 Mass Flow Controller

A mass flow controller employs a diaphragm that actively compensates to maintain a constant mass flow rate. As the differential pressure decreases, the flow rate tends to decrease and the diaphragm responds by opening up to allow more air to pass through. Mass flow controllers can be adjustable or fixed and can provide integrated samples with intervals ranging from hours to days. Air Toxics Ltd. provides a fixed mass flow controller that is calibrated at the laboratory for 24-hour sampling. Adjustable mass flow controllers have a knob that can be adjusted in the field to provide integrated samples with intervals ranging from one to 24 hours. The rugged conditions of field sampling are not usually compatible with adjustable mass flow controllers and Air Toxics Ltd. designed a more reliable flow controller based on a critical orifice design.

2.4.2 Critical Orifice Device

Air Toxics Ltd. designed a critical orifice flow restrictor to provide integrated samples with intervals from 0.5 to 8 hours. The device restricts air flow by forcing the sample to enter a capillary column of minute radius. This device is passive compared to an actively compensating diaphragm and the flow rate decreases as the driving force (differential pressure) decreases. For sampling intervals from 0.5 to

8 hours, however, the flow rate is relatively constant. The main advantages of the Air Toxics Ltd. flow restrictors are improved ruggedness and cleanliness. With no moving or adjustable parts, the Air Toxics Ltd. design is unlikely to lose its flow setting. In addition, a vacuum gauge is built in to the device to monitor sampling progress. To ensure there are no contamination issues from previous use, the capillary column is replaced before shipping to the field.



2.4.3 Sampling Interval and Flow Controller Setting

When you request canisters and flow controllers from Air Toxics Ltd., you will be asked for the sampling interval, and the flow controllers will be pre-set prior to shipment according to the table below. The flow controller is set to collect 5 L of sample over the sample interval. Final canister vacuum is targeted at 5 in. Hg. The flow rate is set at standard atmospheric conditions (approximately sea level). If the air sample is a process (pressurized or under vacuum) or is collected at elevation, the canisters will fill faster or slower depending on the sampling conditions. If you specify the pressure of the source at project set-up, we can set the flow controller accordingly. See Section 4 for a discussion of collecting a sample at elevation. The 24-hr flow controllers should not be used for process or source samples.

Table 2.4.3 Flow Rates for Selected Sampling Intervals (mL/min)

Sampling Interval (hrs)	0.5	1	2	4	8	12	24
6 L Canister	167	83.3	41.7	20.8	11.5	7.6	3.5
1 L Canister	26.6	13.3	6.7	-	-	-	-

Note: Target fill volumes for 6 L and 1 L canisters are 5,000 mL and 800 mL, respectively.

$$\text{Flow Rate(mL/min)} = \frac{\text{Target Fill Volume (mL)}}{\text{Sampling Interval (min)}}$$

2.4.4 Final Canister Vacuum and Flow Controller Performance

Ideally the final vacuum of a 6 L canister should be 5 in. Hg or greater. As long as the differential pressure is greater than 4 in. Hg ambient pressure, then the flow through the device will remain approximately constant as the canister fills. If there is insufficient differential pressure, the flow through the controller will decrease as the canister pressure approaches ambient. Because of the normal fluctuations in the flow rate (due to changes in ambient temperature, pressure, and diaphragm instabilities) during sampling, the final vacuum will range between 2 and 10 in. Hg.

- **If the residual canister vacuum is greater than 5 in. Hg** (i.e., more vacuum), the flow rate was low and less than 5 L of sample was collected. When the canister is pressurized to 5 psig prior to analysis, sample dilution will be greater than normal. This will result in elevated reporting limits.

- **If the residual canister vacuum is less than 5 in. Hg** (i.e., less vacuum), the initial flow rate was high. Once the vacuum decreases below 5 in. Hg, the flow rate begins to drop significantly. This scenario indicates that the sample is skewed in favor of the first portion of the sampling interval.

- **If the final vacuum is near ambient** (i.e., less than 1 in. Hg), there is inadequate differential pressure to drive the flow controller. The sampler cannot be certain the desired sampling interval was achieved before the canister arrived at ambient conditions. The sample could have been acquired over a 1-hour interval (which would be the case if the connection between the canister and flow controller leaked or if the flow controller malfunctioned) or a 24-hour interval. Although the actual sampling interval is uncertain, the canister still contains sample from the site.

Table 2.4.4 Relationship Between Final Canister Vacuum, Volume Sampled, and Dilution Factor (6 L Canister)

Final Vacuum (In. Hg)	0	2.5	5	7.5	10	12.5	15	17.5	20
Volume Sampled (L)	6	5.5	5	4.5	4	3.5	3	2.5	2
Dilution Factor*	1.34	1.46	1.61	1.79	2.01	2.30	2.68	3.22	4.02

* Canister pressurized to 5 psig for analysis

$$\text{Final Reporting Limit} = \text{Method Reporting Limit} \times \text{Dilution Factor (Canister Pressurization)} \times \text{Dilution Factor (Sample Concentration)}$$

$$\text{Dilution Factor (Canister Pressurization)} = \frac{\text{Pressurization for Analysis}}{\text{Receipt Vacuum}} = \frac{14.7\ \text{psig} + \text{Press. for Analysis (psig)}}{14.7\ \text{psig}\left[1 - \dfrac{\text{Rec. Vac. (in. Hg)}}{29.9\ \text{in. Hg}}\right]}$$

2.4.5 Considerations for Integrated Sampling with Canisters

Collecting an integrated air sample is more involved than collecting a grab sample. Sampling considerations include verifying that the media is ready, monitoring the integrated sampling progress, and avoiding contamination.

- **Avoid Leaks in the Sampling Train:** See Section 2.3.1 for instructions on how to securely assemble sampling hardware. A leak in any one of these connections means that some air will be pulled in through the leak and not through the flow controller. A final pressure near ambient is one indication that there may have been a leak.

- **Verify Initial Vacuum of Canister:** See Section 2.3.1 for instructions on verifying initial canister vacuum. If you are using an Air Toxics Ltd. critical orifice flow controller, note that you can use the built-in gauge. It is important to note both the canister and flow controller serial numbers on the chain-of-custody.

- ***Monitor Integrated Sampling Progress:*** *It is a good idea to monitor the progress of the integrated sampling during the sampling interval. The volume of air sampled is a linear function of canister vacuum. For example, halfway (4 hours) into an 8-hour sampling interval, the canister should be half filled (2.5 L) and the gauge should read approximately 17 in. Hg. More vacuum than 17 in. Hg indicates that the canister is filling too slowly; less than 17 in. Hg and the canister is filling too quickly. If the canister is filling too slowly, a valid sample can still be collected (see Section 2.4.4). If the canister is filling too quickly because of a leak or incorrect flow controller setting, corrective action can be taken. Ensuring all connections are tight may eliminate a leak. It is possible to take an intermittent sample. The time interval need not be continuous. Eight 1-hour increments, taken by opening and closing the canister valve, will yield a valid sample.*

Table 2.4.5 Gauge Readings for an 8-Hour Sampling Interval

Sampling Interval (hrs)	0	4	8
Canister Vacuum (in. Hg)	29.9	17.4	5
Volume Sampled (L)	0	2.5	5

- **Avoid Contamination:** *Flow controllers should be cleaned between uses. This is normally accomplished by returning them to the laboratory. For large air sampling projects, Air Toxics Ltd. has designed a field conditioning program for 24-hour flow controllers involving a purge manifold. This arrangement provides the sampler with scheduling flexibility, inventory control, and convenience in the field. Air Toxics Ltd. will provide the 24-hour flow controllers, a purge manifold, Teflon tubing, rubber ferrules, vacuum pump, and flow meter. The sampler will need to provide the certified nitrogen cylinder and the certified high pressure regulator. Call Client Services at 800-985-5955 if you are interested in the field conditioning program.*

- **Keep Sampling Train Out of Direct Sunlight:** The sampling train should be kept out of direct sunlight during sampling. There will be some flow rate drift if the temperature of the controllers is allowed to vary significantly.

2.4.6 Step-by-Step Procedures for Integrated Sampling

These procedures are for a typical ambient air sampling application and actual field conditions and procedures may vary.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, canister, particulate filter, and flow controller)
2. Verify initial vacuum of canister (see Section 2.3.1)

When ready to sample:

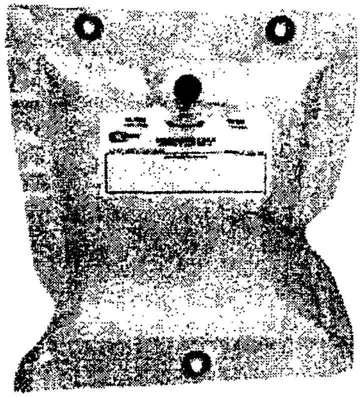
3. Remove brass cap
4. Attach flow controller to canister
5. Attach particulate filter to flow controller
6. Open valve 1/2 turn
7. Monitor integrated sampling progress periodically (see Section 2.4.5)

At end of sampling interval:

8. Verify and record final vacuum of canister (for 24-hr flow controller repeat steps used to verify initial vacuum and for critical orifice device simply read built-in gauge)
9. Close valve by hand tightening knob clockwise
10. Replace brass cap
11. Fill out canister sample tag
12. Return canisters in boxes provided
    - Unreturned canister charge of $450 each
13. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
    - $50-500 per flow controller
14. Fill out chain-of-custody and relinquish samples properly
15. Place chain-of-custody in box and retain pink copy
16. Tape box shut and affix custody seal (if applicable) across flap
17. Ship accordingly to meet method holding times

Section 3. Tedlar Bag Sampling

This section provides a description of Tedlar bags, practical considerations for sampling, and step-by-step instructions for collecting a grab sample. Photographs illustrate the correct way to assemble the various sampling components.



3.1 Introduction to Tedlar Bags

A Tedlar bag is a container used to collect a whole air sample for landfill gas, soil gas, and stationary source applications. The Tedlar bag is best suited for projects involving analysis of compounds in the ppmv range. However, Tedlar bags can be used for other applications such as ambient air monitoring for atmospheric/fixed gases. They can be used to collect sulfur compounds, but only if the fittings are non-metallic (e.g., polypropylene, Teflon, or Nylon).

A Tedlar bag is made of two plies of Tedlar film sealed together at the edges and features a valve that allows the interior to be filled. Sample collection requires a pressurized sampling port, a low flow rate pump, or a lung sampler. The bag expands as sample enters. When the target volume of sample is collected, the valve is closed and the Tedlar bag is returned to the laboratory. Air Toxics Ltd. maintains a limited inventory of Tedlar bags in 1 L, 3 L, and 5 L volumes.

3.1.1 Tedlar Film

Tedlar is a trade name for polyvinyl fluoride film developed by DuPont Corporation in the 1960's. This patented fluoropolymer has been used in a wide variety of applications including protective surfacing for signs, exterior wall panels, and aircraft interiors. Tedlar film is tough, yet flexible and retains its impressive mechanical properties over a wide range of temperatures (well below freezing to over 200° F). Tedlar exhibits low permeability to gases, good chemical inertness, good weathering resistance, and low off-gassing.

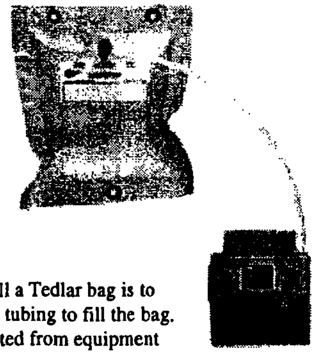
3.1.2 How "Active" Is the Surface of a Tedlar Bag?

The surface of a Tedlar bag is a work in progress. The surface of a new bag is essentially free of VOCs at the single digit ppbv level. Compounds detected from analyzing new Tedlar bags include methylene chloride, toluene, acetone, ethanol, and 2-propanol. Note that 2-propanol has been detected in some new bags up to 45 ppbv. Once the Tedlar bag is used, however, the surface has been exposed to moisture and possibly VOCs. It may irreversibly adsorb many VOCs at the low ppbv level. A series of purges with certified gas will not remove the VOCs from the surface. $15 for a new bag is a small price to pay for peace of mind.

☞ **Never reuse a Tedlar bag when sampling for trace level compounds**

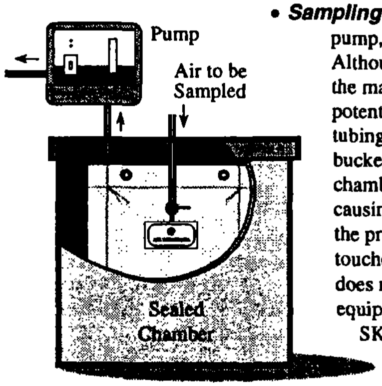
3.1.3 Hold Time for a Tedlar Bag
The media hold time for a Tedlar bag is indefinite if stored out of sunlight in a cool, dry location. Tedlar bags can be used to collect samples containing common solvents, hydrocarbons, chlorinated solvents, sulfur compounds, and many other classes of compounds. The sample hold time to analysis varies for different classes of compounds:

- **1 Day**: Sulfur compounds (e.g., hydrogen sulfide and methyl mercaptan) and chemically active compounds (e.g., 1,3-butadiene).
- **3 Days**: Chlorinated solvents, aromatic compounds, and atmospheric/fixed gases (oxygen, nitrogen, carbon dioxide).



3.2 Tedlar Bag Sampling
Using a Tedlar bag to collect an air sample normally involves "active" sampling, unlike an evacuated canister that can be filled "passively" by simply opening the valve. There are two methods commonly used to fill a Tedlar bag: using a pump or a lung sampler.

- ***Sampling with a Pump***: The most common method to fill a Tedlar bag is to use a small pump with low flow rates (50-200 mL/min) and tubing to fill the bag. Air Toxics Ltd. does not provide pumps but they can be rented from equipment providers or purchased from manufacturers such as Neuberger or Gilian.



- ***Sampling with a Lung Sampler***: Alternatively to using a pump, a "lung sampler" can be used to fill a Tedlar bag. Although a little more complicated than simply using a pump, the main advantage to using a lung sampler is that it avoids potential pump contamination. A Tedlar bag with attached tubing is placed in a small airtight chamber (even a 5-gallon bucket can work) with the tubing protruding from the chamber. The sealed chamber is then evacuated with a pump causing the bag to expand and drawing the sample through the protruding tube into the bag. The sample air never touches the wetted surfaces of the pump. Air Toxics Ltd. does not provide lung samplers, but they can be rented from equipment suppliers or purchased by manufacturers such as SKC Inc.

3.2.1 Considerations for Tedlar Bag Sampling
The following are some considerations for collecting a Tedlar bag sample.

- **Fill the Tedlar bag no more than 2/3 full**: Allow for possible expansion due to an increase in temperature or decrease in atmospheric pressure (e.g., the cargo hold of a plane).

- **Keep the Tedlar bag out of sunlight**: Tedlar film is transparent to ultraviolet light (although opaque versions are available) and the sample should be kept out of sunlight to avoid any photo-chemical reactions.

- **Protect the Tedlar bag**: Store and ship the Tedlar bag samples in a protective box at room temperature. An ice chest can be used, but DO NOT CHILL.

- **Fill out the Tedlar bag label**: It is much easier to write the sample information on the label before the Tedlar bag is inflated.

- **Provide a second Tedlar bag**: Consider filling two bags per location in the rare occasion that a defective bag deflates before analysis.

- **Avoid Contamination**: Care should be taken to avoid contamination introduced by the pump or tubing. Begin sampling at locations with the lowest compound concentrations (e.g., sample the SVE effluent before the influent). Decontaminate the pump between uses by purging with certified air for an extended period; better yet, use a lung sampler. Use shortest length possible of Teflon tubing or other inert tubing. Do not reuse tubing. If long lengths of tubing are used, consider purging the tubing with several volumes worth before sampling. If you are concerned about sampling for trace compounds, you shouldn't be using a Tedlar bag (see Section 1.2).

- **Don't Sample Dangerous Compounds in a Tedlar Bag**: Do not ship any explosive substances, radiological or biological agents, corrosives, or extremely hazardous materials to Air Toxics Ltd. Tedlar bag rupture during transit to the laboratory is possible and the sampler assumes full liability.

3.2.2 Step-by-Step Procedures for Tedlar Bag Sampling (Pump)

Note: These procedures are for a typical stationary source (e.g., SVE system) sampling application; actual field conditions and procedures may vary. See additional sampling considerations in Section 4.3 for sampling soil gas or landfill gas.

Before you get to the field:

1. Verify contents of the shipped package (e.g., chain-of-custody, Tedlar bag, and tubing/fittings – if requested)
2. Verify pump cleanliness and operation (Air Toxics Ltd. does not provide pumps)

When ready to sample:

3. Purge sample port
4. Attach new Teflon tubing from sample port or probe to low flow rate pump
5. Purge tubing
6. Fill out Tedlar bag sample tag
7. Attach additional new Teflon tubing from the pump outlet to the Tedlar bag valve
8. Open Tedlar bag valve
9. Collect sample (FILL NO MORE THAN 2/3 FULL)
10. Close Tedlar bag valve by hand tightening valve clockwise
11. Return Tedlar bag in boxes provided (DO NOT CHILL)
12. Fill out chain-of-custody and relinquish samples properly
13. Place chain-of-custody in box and retain pink copy
14. Tape box shut and affix custody seal (if applicable) across flap
15. Ship priority overnight to meet method holding times. 3 DAY HOLD TIME TO ANALYSIS (most analyses)

Section 4. Special Sampling Considerations

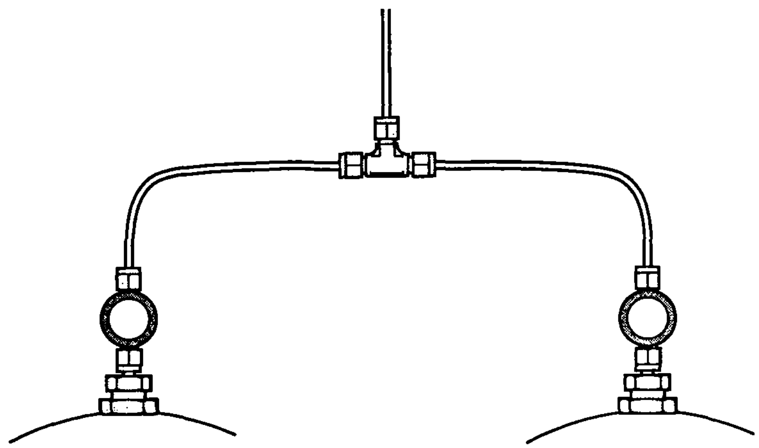
This section provides considerations for special sampling configurations that a sampler may collect in the field such as a field duplicates or an ambient blank. This section also provides considerations for sampling at altitude, soil/landfill gas sampling, and sample cylinder sampling.

4.1 Special Sampling Configurations

Special sampling configurations include a field duplicate, field split, field blank, ambient blank, trip blank, and an equipment rinse. Call Client Services at 800-985-5955 if your project involves any of these special sampling configurations.

4.1.1 Field Duplicate

A field duplicate is a second sample collected in the field simultaneously with the primary sample at one sampling location. The results of the duplicate sample can be compared (e.g., calculate relative percent difference) with the primary sample to provide information on consistency and reproducibility of field sampling procedures. Due to the nature of the gas phase, duplicate samples should be collected from a common inlet. The configuration for collecting a field duplicate includes stainless steel or Teflon tubing connected to a Swagelock "tee". It is imperative that individually certified (i.e., 100% certification process) canisters be used to collect a field duplicate.



4.1.2 Field Split
A field split is similar to a field duplicate in that two samples are collected in the field simultaneously at one sampling location. The main difference is that the samples are sent to separate analytical laboratories. The results of the split samples can be compared (e.g., calculate relative percent difference) to provide information on consistency and reproducibility of analytical procedures between the laboratories. However, due to the nature of air sampling canisters (different surface conditions, cleaning/certification procedures) and differences in analytical laboratory procedures (common in air analysis) the results are almost always meaningless. Please note that Air Toxics Ltd. does not recommend field splits and does not allow Air Toxics Ltd. canisters or other media to be sent to 3rd parties without obtaining prior written consent of Air Toxics Ltd.

4.1.3 Field Blank
A field blank is a sample collected in the field from a certified air source. Analysis of the field blank can provide information on the decontamination procedures used in the field. Clean stainless steel or Teflon tubing and a certified regulator should be used. It is imperative that individually certified canisters (the sample canister and the source canister/cylinder, if applicable) be used to collect a field blank.

4.1.4 Ambient Blank
An ambient blank is an ambient air grab sample collected in the field normally used in conjunction with soil gas or stationary source (e.g., SVE system) sampling. Analysis of the ambient blank can provide information on the ambient levels of site contaminants. It is imperative that an individually certified canister be used to collect an ambient blank.

4.1.5 Trip Blank
When sampling for contaminants in water, the laboratory prepares a trip blank by filling a VOA vial with clean, de-ionized water. The trip blank is sent to the field in a cooler with new sample vials. After sampling, the filled sample vials are placed back in the cooler next to the trip blank and returned to the laboratory. Analysis of the trip blank provides information on decontamination and sample handling procedures in the field as well as the cleanliness of the cooler and packaging.

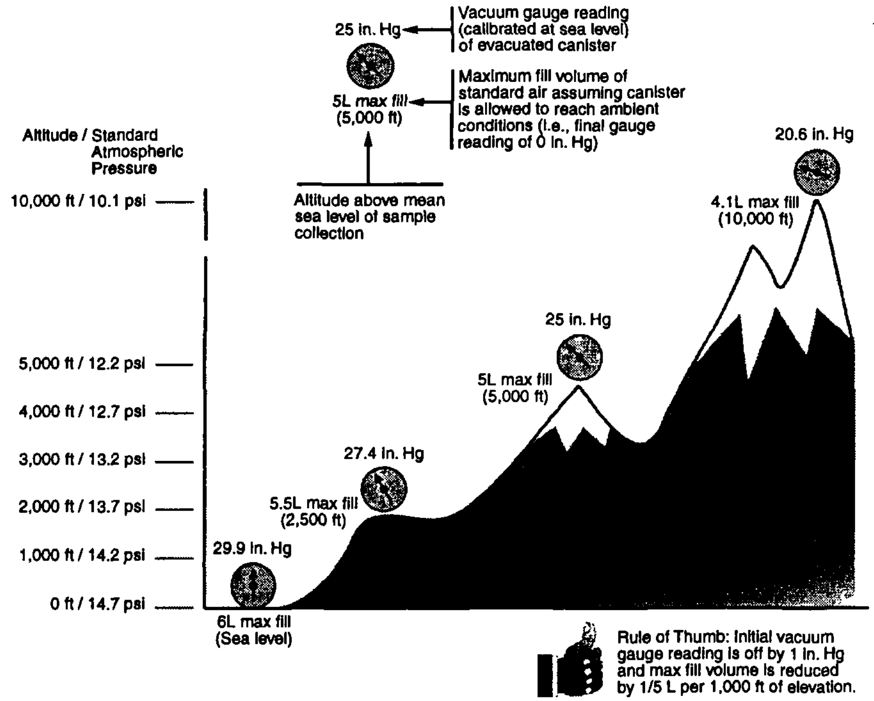
When sampling for compounds in air, a trip blank provides little, if any, of the information above. A trip blank canister can be individually certified, evacuated, and sent to the field in a box with the sample canisters. Since the valve is closed and the brass cap tightened, it is questionable if the trip blank canister contents are ever "exposed" to sampling conditions. At the laboratory, the trip blank canister will be pressurized prior to analysis with dry, zero air – a matrix that may be entirely different than the sampled air. The recovery of target compounds can vary by matrix (e.g., moisture, carbon dioxide) rendering the trip blank results meaningless. Air Toxics Ltd. does not recommend analyzing a trip blank for air sampling.

4.1.6 Equipment Rinse
When sampling for contaminants in water, an equipment rinse is accomplished in the field by rinsing the decontaminated sampling equipment (e.g., bailer, submersible pump, tubing) with clean, de-ionized

water. A portion of the rinse water is collected in a VOA vial for analysis. The equipment rinse is similar to a field blank in that it provides information on decontamination procedures of sampling equipment.

When sampling for compounds in air, an equipment rinse can be used to determine if a sampling train has been properly decontaminated. Certified air is connected to the sampling train and fills an individually certified canister.

4.2 Considerations for Sampling at Altitude
Sampling at altitudes significantly above sea level is similar to sampling a stationary source under vacuum (see Section 4.3) in that target fill volumes may be difficult to achieve. The figure below illustrates the relationship between increasing altitude and decreasing atmospheric pressure. Ambient



conditions in Denver at 5,000 ft altitude are quite different than ambient conditions at sea level. Canister sampling is driven by the differential pressure between ambient conditions and the vacuum in the canister. There is less atmospheric pressure in Denver and 5 L is the maximum fill volume of standard air assuming the canister is allowed to reach ambient conditions (i.e., final gauge reading of 0 in. Hg). Theoretically, if you sample high enough (e.g., in space), no sample would enter the canister because there is no pressure difference between the evacuated canister and ambient conditions. To fill a canister to 6 L in Denver, you would need to use an air pump.

Sampling at altitude also affects gauge readings. The gauges supplied by Air Toxics Ltd. (see Section 2.2.4) measure canister vacuum relative to atmospheric pressure and are calibrated at approximately sea level. Before sampling at altitude, the gauges should be equilibrated (see Section 2.3.1). But even after equilibrating the gauge, verifying the initial vacuum of a canister at altitude is misleading. In Denver at 5,000 ft, expect the gauge to read 25, not 29.9 in. Hg. You do not have a bad canister (i.e., leaking or not evacuated properly). The canister is ready for sampling and the gauge is working properly.

☞ **Rule of Thumb: For every 1,000 ft of elevation, the gauge will be off by 1 in. Hg and the fill volume will be reduced by 1/5 L**

If you have questions about sampling at altitude, please call Client Services at 800-985-5955.

4.3 Considerations for Soil/Landfill Gas Sampling

There are some additional sampling considerations for collecting grab samples (canister or Tedlar bag) from a soil boring, landfill boring, SVE system, or landfill gas (LFG) collection system. The general challenge with these samples arises from the need to employ long lengths of tubing to direct the soil gas, landfill gas, or process air to the canister or Tedlar bag. Tubing introduces the potential for contamination and diluting the sample. A good source of detailed information on soil gas sampling is contained in the ASTM D 5314 Standard Guide for Soil Gas Monitoring in the Vadose Zone.

- **Use inert tubing.** Teflon tubing is recommended. Tubing with an outer diameter of 1/4 in. works best with the fittings on the particulate filter.
- **Do not reuse tubing.** $2 per foot for new tubing is a small price to pay for peace of mind.
- **Purge tubing adequately.** A long length of tubing has significant volume of "dead air" inside. Without purging, this air will enter the canister and dilute the sample. Consider using a hand-held PID/FID to confirm that you have purged the tubing and are drawing sample air through the tubing.
- **Avoid leaks in the sampling train.** Leaks of ambient air through fittings between pieces of the sampling train (e.g., tubing to particulate filter) will dilute the sample.

- **Don't sample too fast.** There is no established flow rate for collecting a soil gas or LFG sample, but sampling slower has advantages. First, any leaks in the sampling train will be less prominent at lower flow rates due to less differential pressure across the leaking connection. Second, sampling slower may allow the conditions in the vadose zone or landfill to equilibrate better and produce a more representative grab sample. Consider using a needle valve or even a 5 micron particulate filter (see Section 2.2.3) to reduce the flow rate into the canister or Tedlar bag.
- **Purge the sample port.** A sample port on a SVE system or LFG collection system can accumulate solids or liquids depending upon the location of the port in the process and the orientation of the port. An influent sample port located upstream of a filter or moisture knock-out can be laden with particulates or saturated with water vapor. Heavy particulate matter can clog the particulate filter and foul the canister valve. It is important to prevent liquids from entering the canister. The presence of water in a canister sample will significantly lower the recovery of both non-polar and polar compounds. A sample port oriented downward may have liquid standing in the valve. Purge the sample port adequately before connecting the sampling train.
- **Consider the effects of sampling a process under vacuum or pressure.** When collecting a grab sample from a stationary source such as an SVE system or LFG collection system, some sample ports may be under vacuum or pressure relative to ambient conditions. When the sample port is under vacuum, such as the header pipe from the extraction well network, it may be difficult to fill the canister with the desired volume of sample. A vacuum pump can be used to collect a canister grab sample from a sample port under considerable vacuum. See the related discussion on sampling at altitude in Section 4.2. When the sample port is under pressure, such as the effluent stack downstream of the blower and treatment system, you may inadvertently pressurize the canister. Only a DOT-approved sample cylinder should be used to transport pressurized air samples (see Section 4.4). Under no circumstances should an Air Toxics Ltd. canister be pressurized more than 5 psig for a 6 L canister and 15 psig for a 1 L canister. Bleed off excess pressure by opening the valve temporarily while monitoring the canister with a pressure gauge.

4.4 Considerations for Sample Cylinder Sampling

Sample cylinders, also known as "sample bombs", are DOT-approved, high pressure, thick-walled, stainless steel cylinders with a valve at each end. They were intended for collecting a pressurized sample for petroleum gas applications. Sample cylinders differ from sample canisters in that they do not have a Summa-passivated interior surface and are not evacuated prior to shipment. Sample cylinders are not suitable for analysis of hydrocarbons at ppbv levels. Sample cylinders can be used for analysis of natural gas by ASTM D-1945 and calculation of Btu by ASTM D-3588. Air Toxics Ltd.

assumes that clients requesting a sample cylinder have a pressurized process and sample port with a built-in gauge and 1/4 in. Swagelock fitting to attach to the sample cylinder. Air Toxics Ltd. has an inventory of 500 mL sample cylinders that are particularly suited for landfill gas collection systems (i.e., LFG to energy applications). This section provides step-by-step procedures for sampling with a sample cylinder.

Step-by-Step Procedures for Sample Cylinder Sampling

These procedures are for a typical stationary source sampling application and actual field conditions and procedures may vary. Follow all precautions in the site Health and Safety Plan when dealing with a pressurized sample port and sample cylinder.

1. Verify contents of the shipped package (e.g., chain-of-custody, sample cylinder, particulate filter)
2. Verify that gauge on sample port is working properly
3. Purge sample port
4. Remove brass caps on either end of cylinder
5. Attach particulate filter to upstream valve
6. Attach filter/cylinder assembly directly to the sample port
7. Open both valves 1/2 turn
8. Allow sample air to flow through sample cylinder (approximately 10 L for a 500 mL cylinder)
9. Close downstream valve of sample cylinder by hand tightening knob clockwise
10. Allow sample cylinder to pressurize to process pressure (max 100 psig)
11. Close upstream valve of sample cylinder and sample port
12. Detach filter/cylinder assembly from sample port and remove particulate filter
13. Replace brass caps
14. Fill out sample cylinder sample tag
15. Return sample cylinder in box provided
    - Unreturned sample cylinder charge of $650 each.
16. Return sample media in packaging provided. Unreturned equipment charges:
    - $45 per particulate filter
17. Fill out chain-of-custody and relinquish samples properly
18. Place chain-of-custody in box and retain pink copy
19. Tape box shut and affix custody seal (if applicable) across flap
20. Ship accordingly to meet method holding times

AIR TOXICS'

Guide to Sorbent-Based Sampling Volatiles and Semi-Volatiles

AIR TOXICS LTD.

AN ENVIRONMENTAL ANALYTICAL LABORATORY

Air Toxics Ltd. Guide to Sorbent-Based Sampling
Volatiles and Semi-volatiles

INTRODUCTION TO AIR SAMPLING

There are essentially four methods used to collect contaminants in a gas phase sample.

- The gas can be collected in a container of some sort. Typically, stainless steel Summa canisters, Tedlar™ bags, glass-lined canisters or glass bulbs are used to collect whole air samples
- The gas can be pulled through a sorbent; contaminants adsorb on the surface and are subsequently removed prior to analysis using either heat or solvent extraction.
- The gas can be bubbled through a solution; the solution is chosen such that the contaminants of interest are either very soluble (and consequently remain in solution) or they are derivatized *in-situ* (and the derivative remains in solution).
- Lastly, filters can be used to remove contaminants adsorbed on particulates in the air. From the filter, the quantity and size distribution of the particulates can be determined or the filter can be solvent extracted or digested to determine the presence of organic and/or inorganic compounds.

Whole air samples are generally the easiest to collect. Guidelines for collecting a whole air sample are discussed in the third edition of Air Toxics' *Guide to Air Sampling and Analysis.* **As a general rule, whole air sampling is best when target compounds are volatile, non-polar and have boiling points less than 160°C**, although exceptions to this rule can be found. Recovery of any given compound in a whole air sample is very much dependent upon the humidity of the sample and the chemical activity of the sample matrix.

When the target compounds are reactive — which can generally be attributed to the presence of hetero-atoms such as oxygen (alcohols, acids, ketones, ethers, glycols, etc.), nitrogen (amines), sulfur (sulfides, mercaptans, etc.) or phosphorus (herbicides) — they are best collected using either sorbents or solutions. These compounds have vapor pressures below 10^{-8} mm Hg, and are commonly considered to be semi-volatile organic compounds (SVOCs).

If collecting a comprehensive range of compounds, a combination of sampling methods must be used. A whole air sample will provide information on volatile organic compounds. A sorbent can be used to collect semi-volatile organic compounds and a solution can be used to collect specific groups of polar compounds: (*e.g.*, an acidic solution of dinitrophenylhydrazine (DNPH) is used to derivatize C_1-C_3 carbonyl compounds).

Introduction to Sorbents

The use of sorbents to collect contaminants in a gaseous sample is conceptually very simple. A pump or vacuum is used to "pull" air through a tube packed with a sorbent. The ability of the sorbent to remove and concentrate contaminants is called sorbent strength. Sorbent strength is generally a function of surface area. The greater the surface area, the greater the sorbent strength. It is necessary to know the rate that the sample is passing through the sorbent tube and the sampling interval in order to calculate the volume of gas sampled.

Rate (Volume/Time) X Time = Volume of Gas Sampled

There are two methods commonly used to remove the contaminants adsorbed on the sorbent surface: *thermal desorption* and *solvent extraction*. *Thermal desorption* is a process where the tube is rapidly heated. The heat releases the contaminants from the sorbent surface and a flow of inert "purge" gas transfers the gaseous mixture to the analytical system. Analysis yields the total mass (e.g., µg) of contaminant present on the sorbent surface. In order to determine the concentration of a given compound in the gaseous sample, simply divide the amount (µg) by the volume of gas sampled (liters or cubic meters). This yields mass ÷ volume which is concentration. As part of the method validation study, the laboratory must determine the proper purge flow and temperature to use. Temperature and flow will be a function of the sorbent used and the compounds of interest. The major advantage of thermal desorption is that all the individual organic compounds are transferred to the analytical system at one time. Low reporting limits can often be achieved by simply increasing the volume of gas sampled. On the other hand, should anything go amiss during analysis, the sample may be lost. The collection of back-up tubes is often standard practice on a sorbent-based sampling project. The major disadvantage of thermal desorption is that compounds with low vapor pressure may not be "released" from the sorbent surface at the desorbtion temperature. Although present in the original vapor sample, they will not be detected and reported.

Solvent extraction will remove contaminants from the sorbent surface, however it is necessary to determine, via desorption efficiencies studies, which solvent is best for a given sorbent / compound pair. Often the laboratory will utilize a "universal" solvent like hexane or methylene chloride and use the recovery of surrogates to monitor extraction efficiency. The extracts are commonly blown to near dryness before being reconstituted in a suitable final solvent. The reporting limit is directly proportional to the final volume of the extract. The more dilute the extract, the higher the reporting limit. Of course, multiple analyses (GC/SCD, GC/FID, GC/ECD, GC/MS) can be performed on a single extract, which allows the analytical process to be optimized for each class of compounds. This also provides a safety net should anything go wrong during analysis.

Advantages of Using Sorbents to Collect a Sample

A variety of sorbents are available so that a sorbent can be selected based upon the target compounds of interest and the expected level of humidity in the sample. In general, Sorbent Strength – a term used to described the affinity of the sorbent for specific organic compounds – is directly proportional to the surface area of the sorbent. The collection of contaminants using sorbent tubes offers a number of advantages over whole air sampling:

> The biggest advantage is **sensitivity**. When collecting a whole air sample, the volume collected and subsequently analyzed is dependent on the container volume. For example, if the sample is collected in a 6L Summa canister, the most that can be collected is 6 – 12L. The most that can be analyzed at one time is 1 – 2 liters. That is, we can remove, concentrate and analyze the organics present in 2 liters, at best. On the other hand, multiple liters can be "pulled" through a sorbent tube. The organics in 10 – 100 liters of air can be concentrated and subsequently analyzed. This provides at least a ten-fold increase in sensitivity.
>
> A second advantage is **sample integrity**. Sample integrity depends on (1) stability and (2) the prevention of contamination. The sorbent tube is the first element in a very simple sampling train, which greatly reduces the possibility of sample contamination during collection. In addition, the tubes are easily cleaned and stored prior to use. Sample stability is enhanced because the compounds

are immobilized (*i.e.*, adsorbed) on the surface, which minimizes the possibility for chemical reactions. The sample will generally not degrade while immobilized on a sorbent surface. Hold times are on the order of weeks, not days.

Lastly, the sampling train is quite **simple**. Several tubes can be stored in a small cooler. The pump can be operated using a battery pack or a car battery. Taking samples over time – up to one week – is straightforward.

Disadvantages of Using Sorbents to Collect a Sample

There are, of course, a few disadvantages that must be taken into account when using sorbent tubes. The most serious of which is over-sampling. The adage, "If a little bit is good, a little bit more is better," often finds its way into sorbent sampling protocols. There are those that, in an attempt to ensure low reporting limits, will over-sample. Two things happen when sorbent tubes are over-sampled, and both are bad.

When over-sampling a sorbent tube, there is always the possibility that **high levels of both target and non-target "matrix" compounds will be trapped**. When thermally desorbed, the compounds may overload the analytical equipment during analysis, which will obviously compromise data quality. There are procedures for screening VOC sorbent samples prior to analysis. A simple procedure based on Tedlar bags is discussed on page 14. SVOC samples are diluted either during sample preparation – increasing the volume of the extract – or by decreasing volume injected on the analytical system. Of course, sample dilution will often preclude the determination of low-level target compounds.

Using a technique referred to as **distributed sampling** allows the field sampling team to ensure that valid data will be obtained. Samples are collected using a series of sampling volumes. For example, 1, 5, and 10L samples are collected. Initially, the 1-liter sample is analyzed and the data reviewed within the context of the project DQOs. A decision is made regarding the "best" sample volume. Subsequent samples intervals are adjusted accordingly. Distributive sampling can be used for all sampling events or at one or two "typical" sites. It is interesting to note that all sorbent-based EPA methods discuss using distributive sampling as a part of routine testing, yet it is rarely done.

For each combination of factors such as target compound, humidity and sorbent, there is specific **Retention Volume** – the volume of gas required to move a compound from one end of the sorbent tube to the other. If the retention volume is exceeded, loss of compound occurs. Another term that is commonly used in this context is **Breakthrough Volume** – the volume of air containing a constant concentration of compound which may pass through the tube before a detectable level of the compound elutes from the "nonsampling" end. Using sorbent tubes in series can monitor breakthrough. The second, or backup tube, is only analyzed if a predetermined level of a given compound or total mass is found on the "first" tube. While the use of a backup tube will increase media costs, it has little effect on sampling costs. It will, however, provide definitive support for data integrity. Recent EPA sorbent-based methods, such as TO-17, specify the use of multiple synthetic, polymeric sorbents in each tube. This greatly reduces the possibility of breakthrough. Breakthrough problems are rarely a factor with SVOCs.

Keep in the mind that the migration of any compound through the tube is temperature dependent. **Sorbent tubes should generally be kept at ambient temperature during sample collection.**

Calculating the Volume to Sample

The most often asked question when collecting a sorbent-based sample is, "How much vapor should be sampled?" The reporting limit for a sorbent-based method is a function of two factors: the volume of vapor sampled and the sensitivity of the analytical system.

$$\textbf{Reporting Limit } f \textbf{ (volume sampled) (method reporting limit)}$$

The greater the sensitivity of the analytical equipment, the lower the method reporting limit. Generally, state-of-the-art GC/MS systems can accurately quantitate 5-10 ng of a given VOC (1.0 μg of SVOC) in the full scan mode of operation. This can be further reduced by a factor of 5-10 by using selected ion monitoring (SIM). Of course, reporting limits increase for reactive or unstable analytes because they are often difficult to remove (recover) from the sorbent surface and/or may undergo degradation during the chromatographic process.

The second factor affecting the final reporting limit is the volume sampled. Clearly, by collecting a larger volume of sample, more mass will be adsorbed on the surface. The more mass analyzed, the higher the response and the lower the reporting limit.

The volume of sample to be collected is dependent on both the required reporting limit *and* the compounds' breakthrough volume on the sorbent being used. The thought process is outlined below:

1. What is the analyte(s) of interest and the required reporting limit?

2. What is the method reporting limit? This is provided by the laboratory and is based on a statistically significant Method Detection Limit (MDL) study.

3. Calculate the volume that must be sampled in order to achieve the required reporting limit using this equation:

Volume to sample (L) = method reporting limit (µg) ÷ required reporting limit (µg/L)

4. Refer to tables of Retention Volume (RV) for the sorbent being used – the best source is Table 1 and Appendix I in Method TO-17. If the RV for the compound of interest is not available, use the RV of a compound in the same class (e.g., toluene for xylene, chloroform for carbon tetrachloride, etc.) and ensure that the compound will not breakthrough when sampling the volume calculated using the equation above. If breakthrough is a possibility, select a sorbent with a greater retention volume – that is, surface area.

As an example to demonstrate this sequence:

Steps 1 and 2

Assume the compound of interest is benzene and it must be reported at 0.0005µg/L. The method reporting limit, provided by the laboratory, is 10 ng (0.010 µg).

Step 3

Liters to sample = method reporting limit (µg) ÷ required reporting limit (µg/L)
Liters to sample = 0.010/0.0005
Liters to sample = 20L

Step 4

TO-17 Appendix I shows that up to 26L can be collected using a Type 3 (CarboTrap 300) multi-sorbent tube.

Conclusion

Benzene can be reported at 0.0005µg/L. The rate of sample collection is usually written into the method. General guidelines for several methods are given in the tables starting on page 8.

Effects of Moisture on Sorbent Efficiency

Moisture retained on the sorbent tube may affect collection efficiency, as well as the gas chromatographic column and/or detector. A single tube, packed with multiple hydrophobic sorbents, is used for collecting VOCs, in order to minimize water collection. However, often the collection of water (especially when sampling high (>65%) humidity vapor) cannot be avoided. It is important to note that when sampling in any humidified air stream, the greatest uptake of water takes place in the first 0.25 liters. Water present in the tube does not appreciably increase as additional vapor passes through the tube.

Moisture primarily affects the collection of volatile gases – recovery will vary as a function of the sample humidity. Typical affected compounds include Freon 12, vinyl chloride, methylene chloride and perhaps chloroform. Compounds with vapor pressures greater than chloroform will not be affected by humidity. Variable collection efficiency is obviously only a concern when collecting VOCs. Sorbent strength is not affected by humidity when collecting semi-volatile compounds.

SORBENTS FOR VOLATILE ORGANIC HYDROCARBONS (VOCS)

(Much of this information was distilled from EPA Method TO-17: EPA/625/R-96/010b)

Sorbents have long been utilized in air sampling for VOCs. Many NIOSH methods utilize charcoal as a primary sorbent for organics. Early EPA Methods used a polymeric resin – Tenax – to collect organics in air. Recently, new polymeric sorbents have become commercially available. These have been written into virtually all new EPA methods. As a general rule, the new, synthetic sorbents are vastly superior to charcoal and Tenax and, in fact, have or shortly will replace coconut charcoal and Tenax as the sorbents of choice. The Table below summarizes the most common sorbent-based EPA Methods:

Table 1 – Sorbent Characteristics for Sorbent-based EPA VOC Methods

EPA Method	Sorbent	Surface Area	Compound Applicability (boiling point)
TO-1	Tenax (1.6 g)	50 m^2/g	80 – 200° C
TO-2	CMS (0.4 g)	1000 m^2/g	-15 – 120° C
TO-17*	Multi-sorbent	Varies	-40 – 400° C
0030/5041A VOST	Tenax/petroleum based charcoal	50 m^2/g	30 – 100° C

* There are three general-purpose multi-bed sorbent tubes discussed in the method. ATL has extensive experience with Tube Style 3: Carbotrap 300 (Supelco, Inc.) - 13mm Carbopack C (surface area = 50m^2/g), 25mm Carbopack B (surface area = 100-500m^2/g) and 13mm of Carbosieve S-III (1000m^2/g). This tube can be used for compounds ranging in volatility from n-C_3 to pyrene for air volumes of 2L at relative humidity below 65% and tube temperatures below 25°C. Volumes greater than 5L can be collected, but C_3 compounds are not quantitatively retained. Moisture primarily affects the collection efficiency of volatile gases.

Method Specific Guidelines for Collecting Sorbent Samples

Sorbent tubes are either stainless steel, glass-lined stainless steel or glass. The choice of material is not important for collecting most nonpolar VOCs; however, when collecting reactive compounds such as amines or mercaptans, glass or glass-lined tubes should be used. Typical tube configurations for the four methods listed in Table 1 are illustrated. Approximate dimensions are provided to assist in selecting the proper connection tubing. Suitable pumps are also listed for each method.

TO-1: Determination of Volatile Organic Compounds in Ambient Air using Tenax Adsorption and Gas Chromatography / Mass Spectrometry (1984)

Media	1.6 grams Tenax
Media Hold Time	2 weeks
Type of Pump Recommended	Kneuberger
Sampling Volume	Very dependent upon target analytes – see Method table
Sampling Rate	50 – 500 mL/minute
Storage Temperature	-20° C
Hold time to Analysis	2 weeks
Analytical Method	Thermal desorption, GC/MS

TO-1 Tube

TO-2: Determination of Volatile Organic Compounds in Ambient Air by Carbon Molecular Sieve Adsorption and Gas Chromatography / Mass Spectrometry (1984)

Media	≈ 0.4 grams Carbon Molecular Sieve (CMS)
Media Hold Time	2 weeks
Type of Pump Recommended	Kneuberger
Sampling Volume	30 – 100 Liters
Sampling Rate	20 – 500 mL/minute
Storage Temperature	Not Provided; ATL recommends 4° C
Hold Time to Analysis	Not Provided, ATL recommends <30 days
Analytical Method	Thermal desorption, GC/MS

TO-2 Tube

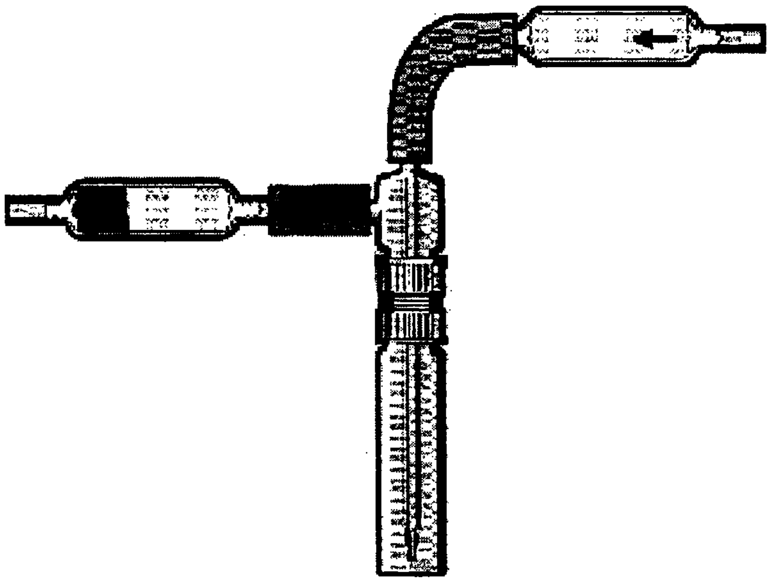
TO-17: Determination of Volatile Organic Compounds in Ambient Air using Active Sampling onto Sorbent Tubes (1997)

Media	Multiple sorbents. ATL has experience using CarboTrap 300
Media Hold Time	Suggests up to 60 days @ 4° C
Type of Pump Recommended	Personal pump or Kneuberger
Sampling Volume	1 & 4 liters over 1 hour
Sampling Rate	10 – 200 mL/minute
Storage Temperature	4° C
Hold Time to Analysis	Suggests up to 1 year
Analytical Method	Thermal desorption; GC/MS (other detectors can be used)

TO-17 Tube

Method 0030/5041A: Volatile Organic Sampling Train (VOST)

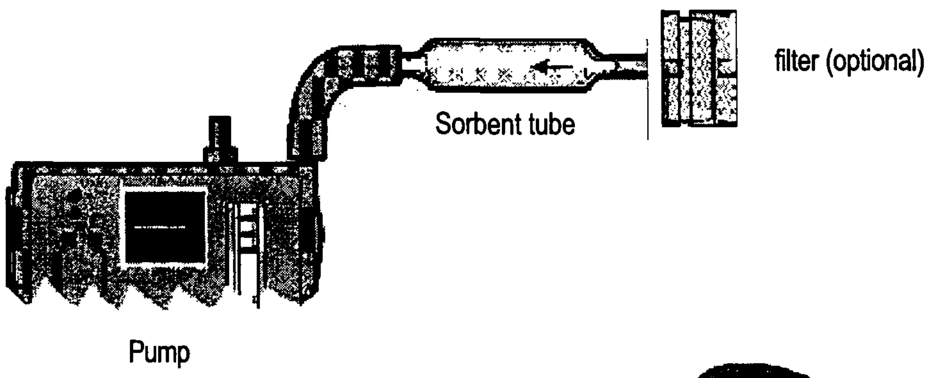
Media	1.6 g Tenax and 1.0 g Tenax / 1.0 g petroleum based charcoal
Media Hold Time	2 weeks @ 4° C (shipped cool)
Type of Pump Recommended	Thomas Model 107 or equivalent
Sampling Volume	20L (alternately 5L @ 0.25 L/minute or 20L @ 0.5 L/minute)
Sampling Rate	1 L/minute
Storage Temperature	4° C
Hold Time to Analysis	14 Days
Analytical Method	Thermal desorption – purge and trap; GC/MS

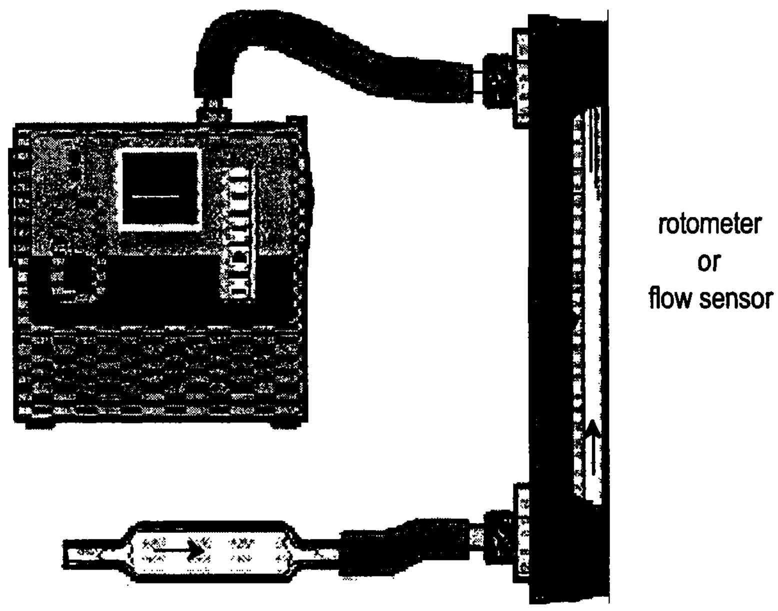


VOST Sampling Train

Common Sorbent Tube Sampling Trains

The sampling train for VOCs is very simple. A typical train is illustrated below. Because tubing used to connect the sorbent tube to the pump does not come in contact with the sample, the tubing material can be selected on its ability to seal. Tygon is excellent, although nylon and Teflon can be used. The length of the tube is also unimportant. **It is critical that the air be pulled through the tube in the direction of the arrow marked on the tube.** The arrow should "point" toward the pump. In the laboratory the flow through the tube is reversed to ensure complete recovery of the adsorbed analytes. Proper orientation is especially important when using the TO-17 multi-bed tubes. If the low vapor pressure analytes are adsorbed on the high surface area sorbent – the one designed for gaseous compounds like vinyl chloride – they cannot be removed at the desorption temperatures routinely used.

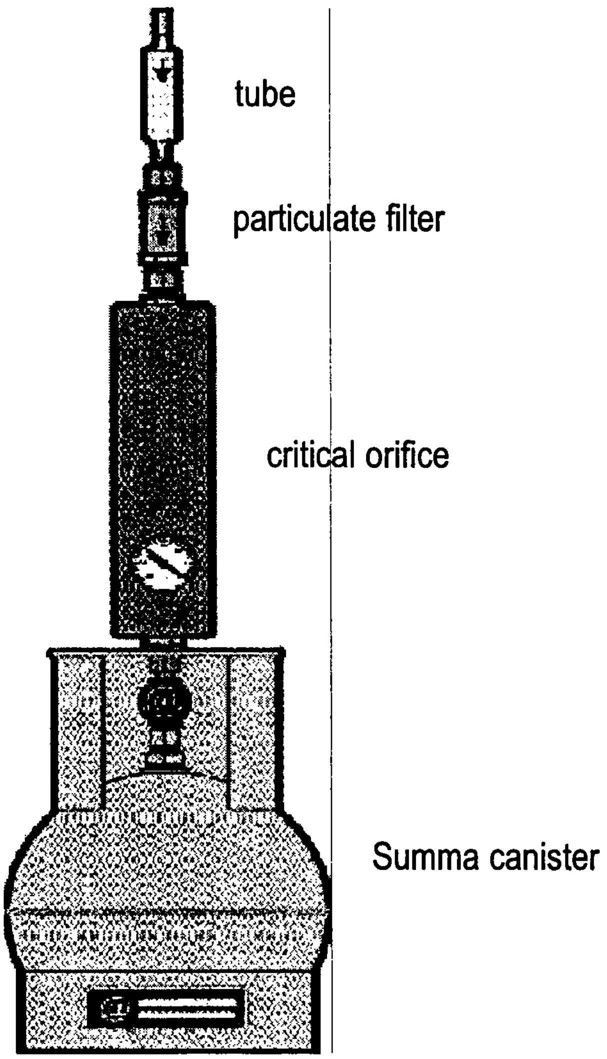




It is imperative to know the flow through the sorbent tube and the sampling interval. A "set up" tube is often used to set the pump flow rate. It must be very similar to the actual tubes being used for sample collection. It is the pressure drop (ΔP) through the tube that determines the flow through the tube for a given pump setting. The flow through the tube should be monitored continuously (or at lest periodically) using an in-line rotometer or an electronic flow sensor (as shown on the previous page). If the air is known to have high levels of particulate matter, it may be necessary to place a filter at the tube inlet. *In this case the connecting tubing (between the filter and the tube) will be in the sampling stream and it should be NEW Teflon and as short as possible.*

If the sampling flow is greater than 200mL/min, simple rotometers and electronic flow sensors cannot be used. It is necessary to use a device capable of measuring high flows. Refer to the Method for information on the proper method of measuring the flow.

An alternative to using a pump is available if sampling less than 5L. An evacuated 6L canister can be used to "pull" air through the tube. No power is required and the sampling rate will be constant over a working range of 0.5 - 24 hours. The on/off valve on the canister must be closed when the selected time interval has passed. This sampling train is illustrated.



Returning the Sorbent Tube to the Laboratory

Once sample collection is complete, replace the stainless steel end caps on the tube. Tighten so that the fittings cannot be rotated by hand and place the sealed tube in the culture tube used for shipping. This culture tube contains activated charcoal to remove contaminants from the ambient air. Store the tubes in a refrigerator or freezer until shipment.

Finally, it is important to note that transportation and storage of all sorbent tubes should be at sub-ambient temperatures both prior to and after sample collection. Low temperature helps stabilize the analytes adsorbed on the surface and precludes any loss of compounds due to temperature fluctuations. All of the VOC and SVOC sorbent-based methods require storage and shipment at 4° C.

The use of blue ice alone will not lower the temperature to 4° C. Water ice, placed in 2 ziplock bags, sealed tightly, is best for this application. A vial (for example, a 40 mL VOA bottle) of water should be included when returning the tubes to the laboratory. This allows the laboratory to easily document the temperature upon sample receipt.

What if the Tubes are Over-Sampled?

Once the laboratory receives the tubes, they are analyzed according to the instructions contained in the client's Project Profile and the chain-of-custody. If the first few tubes analyzed have an excessive amount of organic mass, analysis is halted. The Client Service Coordinator is notified and options are discussed. The Client Services Coordinator contacts the client and, together, they decide upon a course of action. Very often the decision is to dilute the sample prior to analysis.

Air Toxics Ltd. has validated a method of performing sample dilutions for sorbent tubes. Normally for VOC analysis sorbent tubes are thermally desorbed; the entire sample is transferred onto the analytical system. In those cases where the amount of analyte on the tube exceeds the capacity (or the calibration range) of the GC/MS, data of questionable quality is obtained. The approach adopted by Air Toxics involves the thermal desorption of the tube into a Tedlar bag. Prior to desorption, a known amount of deuterated benzene is injected on the tube. The recovery of the benzene-d6 indicates the efficiency of the transfer.

After the sample and benzene-d6 is desorbed into a Tedlar bag, the gas phase sample is screened using GC/FID. From this screen, the analyst determines the amount of sample to analyze on the GC/MS system. This is accomplished by injecting a known volume[1] of sample onto a clean sorbent tube, which has been previously spiked with internal standards and surrogates. This tube is subsequently analyzed using the parameters outlined in the project specific QAPP. Data of high quality is obtained.

The table below illustrates the recovery of benzene-d6 from two tubes. Note that in both cases the high recovery lends scientific credence to this method of sample dilution.

Sample Description	Recovery of Benzene-d6
Tube 3401: Bag dilution to 708mL/35 mL analyzed	97%
Tube 3402: Bag dilution to 708mL/35 mL analyzed	95%

(1) It is possible to inject the entire volume of the Tedlar bag onto a clean tube without loss. This is useful in those cases where the first one or two tubes have high levels of analytes and a decision is made to perform bag dilutions on the remaining tubes. If a bag dilution is made and the screen indicates that it was unnecessary for a particular sample, the entire sample can be recovered and analyzed. Data quality is unaffected.

Sorbents for Semi-Volatile Organic Compounds (SVOCs)

There are a number of sorbents used for the collection of semi-volatile organic compounds. Because SVOCs, by definition, have low vapor pressures ($<10^{-8}$ mm Hg), they migrate very slowly, if at all, through a sorbent bed. There is little concern about Retention Volumes or Breakthrough Volumes. Rather, the problem is getting a sufficient volume of sample through the tubes so that the target analytes can be detected. Recovery of the analytes from the sorbent surface is via solvent extraction. This can be accomplished by sonication or soxhlet extraction.

The relationships between reporting limit, volume sampled and method detection limits is the same as for VOCs:

Reporting Limit f (volume sample) (Method Reporting Limit)

Using a low resolution, quadrupole GC/MS, method reporting limits are on the order of 0.5 – 1 µg for most SVOC compounds. Consequently, large volumes must be collected in order to achieve reporting limits normally associated with health-based risk assessment. Flow rates on the order of liters/minute are common. The calculations are similar to those described on page 5. High flow rates do mandate that high capacity pumps and measurement devices be used. These are often described in the Method itself.

The most common SVOC Methods are listed in the Table below:

Table 2 - SVOC Sorbent-based Methods

Method	Sorbent	Compound Classes
TO-4A	PUF [1]	Pesticides/PCBs
TO-10A	PUF	Pesticides/PCBs
TO-9 [2]	Quartz Filter/PUF	Dioxins
TO-13A	Quartz Filter/PUF/XAD-2	SVOCs, PAHs
0010/8270C	Quartz Filter/XAD-2	SVOCs, PAHs

1 PUF = Polyurethane Foam

2 High resolution GC/MS - method not performed by Air Toxics.

Method Specific Guidelines for Collecting Sorbent Samples

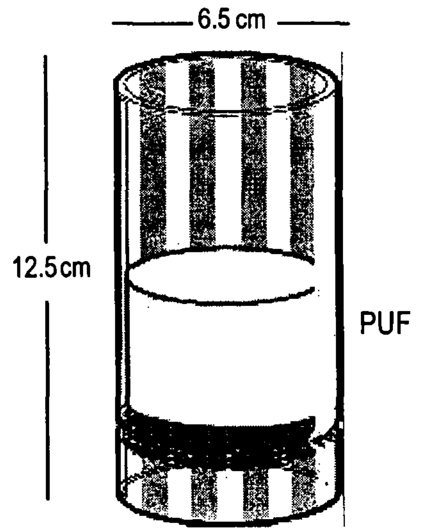
Sorbent cartridges are commonly glass. Typical cartridge configurations for the four methods listed in Table 2 above are illustrated. Approximate dimensions are provided to assist in selecting the proper connection tubing. Suitable pumps are also listed for each method.

TO-4A: Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using High Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Multi-detector Detection (GC/MD) (1999)

Media	PUF + 102mm quartz fiber filter
Media Hold Time	30 days from date of certification
Type of Pump Recommended	High Volume Sampler *
Sampling Volume	Determined using the laboratory method reporting limit and the desired reporting limit – see equation, page 5
Sampling Rate	4-10 SCFM (0.114-0.285 m^3/min)
Hold Time to Extraction	7 days @ 4° C
Extract Hold Time	40 days
Analytical Method	GC/ECD/NPD/FPD/HECD/MS or HPLC/UV

* General Metal Works, Village of Cleves, Ohio, Model PS-1. Other manufacturers include: Tisch Environmental, Village of Cleves, Ohio, Anderson Instruments, 500 Technology Ct, Smyma, GA and Thermo Environmental Instruments, 8 West Forge Parkway, Franklin, MA.

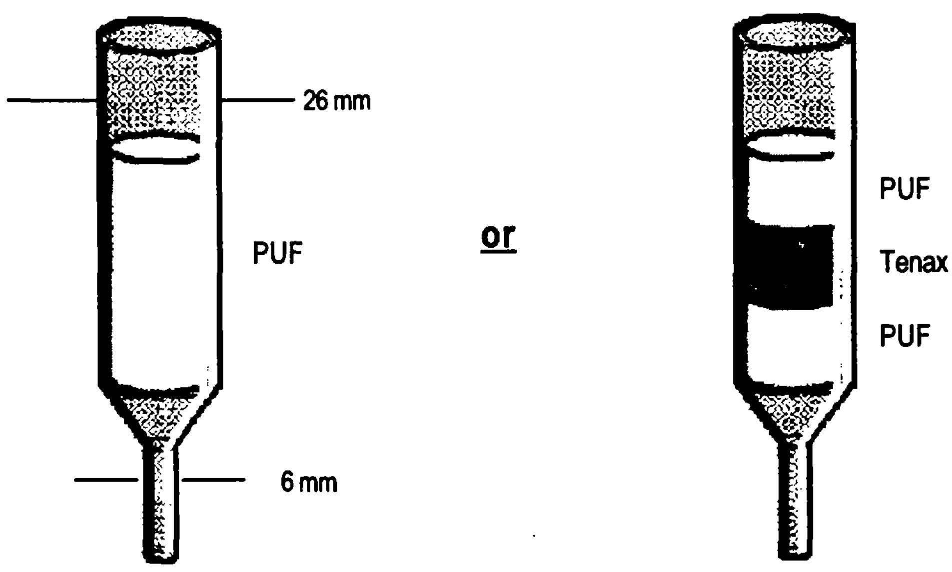
TO-4 Cartridge



TO-10A: Determination of Pesticides and Polychlorinated Biphenyls in Ambient Air using Low Volume Polyurethane Foam (PUF) Sampling followed by Gas Chromatographic / Multi-detector Detection (GC/MD) (1999)

Media	PUF or PUF + 0.6 grams of Tenax-TA 32mm quartz micro fiber filter optional
Media Hold Time	30 days from date of certification if stored in sealed container. Shipped at ambient temperature
Type of Pump Recommended	1 – 5 L/minute (±5%) personal air pump *
Sampling Volume	Determined using the laboratory method reporting limit and the desired reporting limit
Sampling Rate	1 – 5 L/minute
Hold Time to Extraction	7 days @ 4° C
Extract Hold Time	40 days
Analytical Method	GC/ECD/NPD/FPD/HECD/MS or HPLC/UV

* Manufacturers include: Tisch Environmental, Village of Cleves, Ohio, Anderson Instruments, 500 Technology Ct, Smyma, GA and Thermo Environmental Instruments, 8 West Forge Parkway, Franklin, MA.

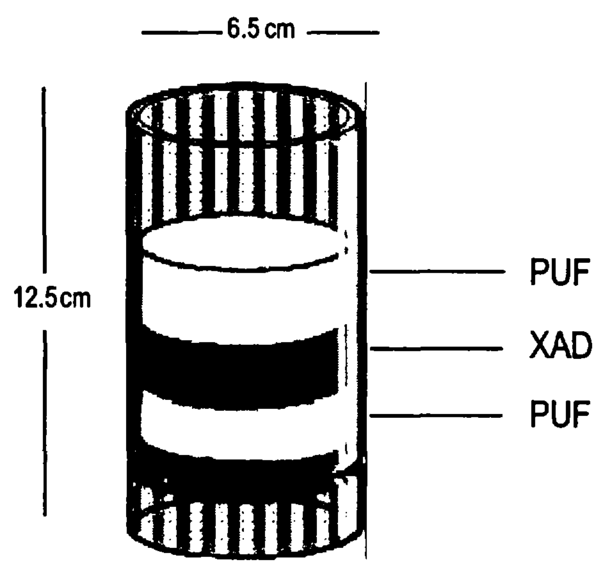


TO-10 Cartridge

TO-13A: Determination of Polycyclic Aromatic Hydrocarbons (PAHs) in Ambient Air using Gas Chromatography / Mass Spectrometry (GC/MS) (1999)

Media	PUF / 102 mm binderless quartz fiber filter. XAD-2 resin optional
Media Hold Time	30 days from date of certification
Type of Pump Recommended	High Volume Sampler *
Sampling Volume	>300 ft^3 over 24 hours
Sampling Rate	4-10 SCFM (0.114-0.285 m^3/min)
Hold Time to Extraction	7 days @ 4° C
Extract Hold Time	40 days
Analytical Method	GC/MS

* General Metal Works, Village of Cleves, Ohio, Model PS-1. Other manufacturers include: Tisch Environmental, Village of Cleves, Ohio, Anderson Instruments, 500 Technology Ct, Smyma, GA and Thermo Environmental Instruments, 8 West Forge Parkway, Franklin, MA.



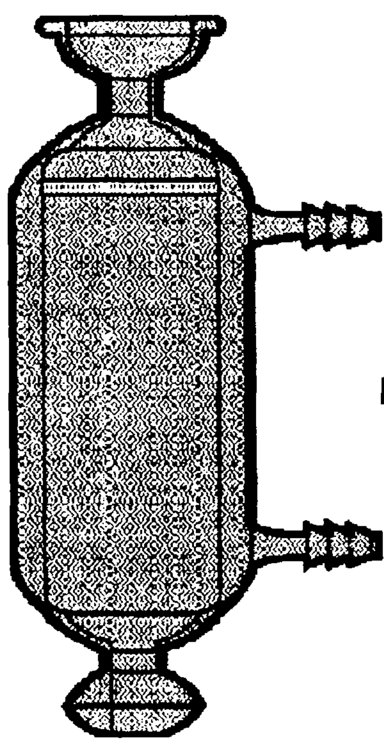
TO-13 cartridge

Method 0010: Modified Method 5 Sampling Train

Determination of Destruction and Removal Efficiency (DRE) of Semivolatile Principal Hazardous Compounds (POHCs) from Incineration Systems

Media	≈ 20 gram XAD-2 / glass or quartz fiber filter
Media Hold Time	4 weeks from date of preparation
Type of Pump Recommended	High Volume Sampler * capable of at least 4 cfm free flow
Sampling Volume	3 dscm min. or as needed to achieve project reporting limits
Sampling Rate	Isokinetic
Hold Time to Extraction	Not Provided – ATL uses 7 days @ 4° C (ship all liquid samples @ 4° C; filters are shipped unrefrigerated)
Extract Hold Time	40 days
Analytical Method	GC/MS

* General Metal Works, Village of Cleves, Ohio, Model PS-1. Other manufacturers include: Tisch Environmental, Village of Cleves, Ohio, Anderson Instruments, 500 Technology Ct, Smyma, GA and Thermo Environmental Instruments, 8 West Forge Parkway, Franklin, MA.

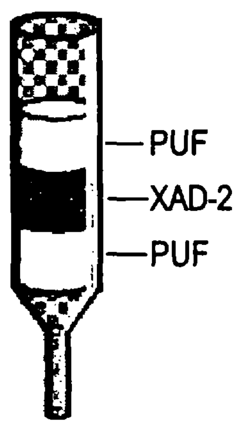


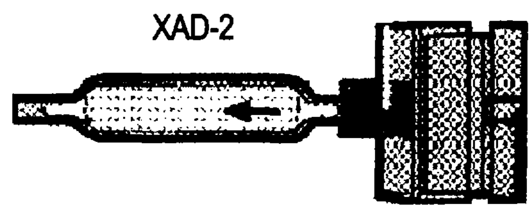
Modified Method 5 XAD-2 Cartridge

Modified Sampling Media for Indoor Air Projects

The methods cited above are written for the determination of SVOCs in ambient air or stationary source emissions. They are not really suitable for collecting indoor air samples. Placement of a PS-1 high volume sampler in someone's home or office would be considered intrusive and impractical, at best. Modifications of these methods are common. The two most common modifications utilize the sample cartridge specified in TO-10A or a high capacity glass tube. This tube configuration is often referred to as a "VOST" tube. The TO-10A cartridge is packed with a combination of XAD-2 and PUF; it may be used with or without a quartz filter. The "VOST" tube is packed with XAD-2 and it too may be used with or without a particulate filter. Both of these configurations are provided by Air Toxics on a project specific basis.

Modified TO-10 Cartridge





Modified "VOST" tube

Because of the pressure drop associated with having a packed bed of XAD-2 resin in the sampling tube, personal sampling pumps (like those normally used with small NIOSH sorbent tubes) may prove inadequate, given that a large volume of air that must be sampled. These small pumps will have difficulty pulling flows greater than a few mL/min through the tube. A high capacity Kneuberger pump is powered by 12v – using a 12 volt converter or a 12 volt car battery.

The table below shows the relationship between reporting limit and the method reporting limit (MRL) for three different sample volumes. Clearly a balance must be sought between the time spent collecting the sample and the configuration of the sorbent tube. A fixed volume can be sampled in a shorter period of time using higher flow rates.

Method Reporting Limit	Volume Sampled	Reporting Limit
1.0 μg	$325 m^3$ or 325000L	30.08×10^{-6} μg /L
1.0 μg	20 L	0.05 μg/L
1.0 μg	50 L	0.02 μg/L

Note: The reporting limits required by the project data quality objectives will determine the volume sampled. Method reporting limits are provided by the laboratory and are based upon a statistically significant MDL study.

Returning the Glass Cartridge to the Laboratory

Once sample collection is complete, replace the end caps on the tube. For "VOST" tubes, tighten the fittings so that they cannot be rotated by hand and place the sealed tube in the culture tube used for shipping. This culture tube contains activated charcoal to remove contaminants from the ambient air. For TO-4A, TO-10A and TO-13A tubes, replace the plastic caps and Teflon liners.

Sample identification notations should *NEVER* be written on the glass cartridge itself. The entire glass tube may be placed in the soxhlet extraction apparatus. If the identifications are written on the glass, chemicals in the ink will be extracted along with the actual sample.

Wrap the tube with aluminum foil. Place in a plastic bag. **Store the tubes in a refrigerator or freezer until shipment.**

Finally, it is important to note that transportation and storage of all glass cartridges should be at sub-ambient temperatures both prior to and after sample collection. Low temperature helps stabilize the analytes adsorbed on the surface and precludes any loss of compounds due to temperature fluctuations. All of the VOC and SVOC sorbent-based methods require storage and shipment at 4° C.

The use of blue ice alone will not lower the temperature to 4° C. Water ice, in 2 ziplock bags, sealed tightly, is best for this application. A vial (for example, a 40 mL VOA bottle) of water should be included when returning the tubes to the laboratory. This allows the laboratory to easily document the temperature upon sample arrival.

What if the Tubes are Over-Sampled?

Once the laboratory receives the tubes, they are analyzed according to the instructions in the Project Profile. The extracts are screened using GC/FID prior to analysis. The "screen" chromatogram is used to determine the volume of extract injected on the GC/MS. Every effort is made to ensure that the maximum amount of sample is analyzed consistent with project data quality objectives. For some projects this means that all target compounds must be within the calibration range. Other projects will accept CLP data qualifiers. This sort of information is included in the Project Profile used by the Laboratory. Extracts are stored in a monitored freezer and can be, if the need arises, re-analyzed.

For more information

Copies of the individual Air Toxics Methods (TO-1 through TO-17), as well as the full text of the *1999 TO Compendium of Methods, Second Edition*, can be obtained from: EPA's Office of Air Quality Planning & Standards - AMTIC (Ambient Monitoring Technology Information) center on the Technology Transfer Network TTNWeb:

www.epa.gov/ttnamti1/airtox.html

For more information about air sample analysis, contact Air Toxics:

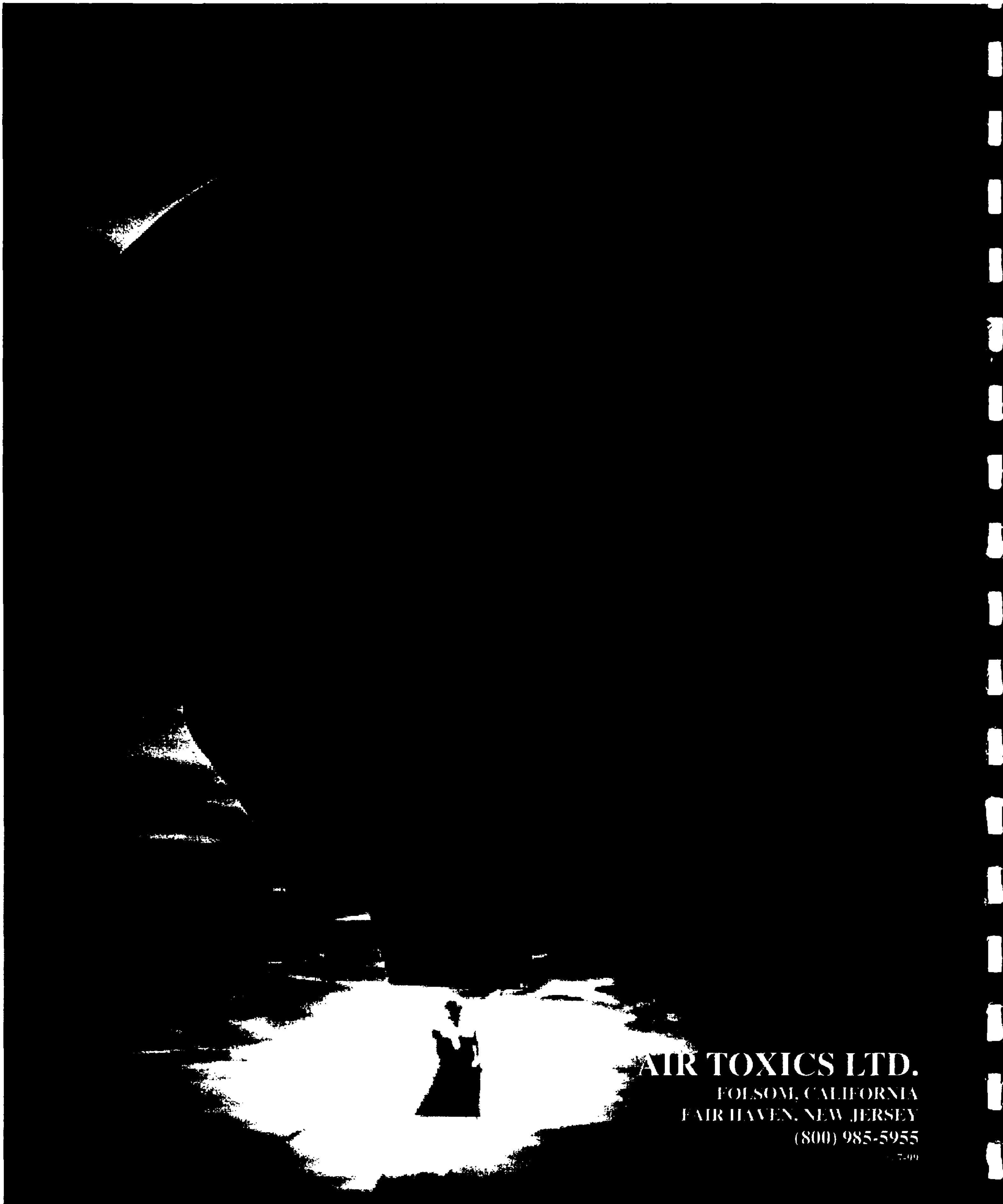
call: Client Services at 916-985-1000 or 800-985-5955

fax: Client Services at 916-985-1020

write: AIR TOXICS LTD.
180 Blue Ravine Road
Suite B
Folsom, CA 95630

email: ATL@ns.net

visit our website: www.airtoxics.com



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